PROXIMAL FEMORAL FRACTURES: A CASE STUDY IN THE EVALUATION OF HEALTH CARE.

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DECLARATION.

I declare that this thesis has been composed by me and that the work contained herein is my own.

The work relating to trends in national hospital morbidity data for proximal femoral fractures has been published elsewhere [1].

ABSTRACT.

Proximal femoral fractures occur mainly in elderly people and, because of the increasing proportion of very old people in modern societies, they have required increasing amounts of scarce health care resources. This case study in the evaluation of health care considers whether these resources are well used. The findings of a one year prospective cohort study of proximal femoral fractures in persons aged 25 years or older who were residents of Stockport are presented. An attempt was made to describe these patients, to quantify the patient-days in hospital and methods of treatment, and to assess the outcome of health care in terms of morbidity and mortality after an interval of 6 months from the fracture. Routine mortality and hospital morbidity statistics were also examined. In general, the primary treatment of proximal femoral fractures is surgical. They provide a convenient example of health care for elderly people and, in the broadest sense, of technology in health care. Although there is some evidence that the efficiency of hospital care for these fractures has improved in recent years in England and Wales, this study suggests that the outcome is still unsatisfactory. This is particularly so for those elderly people who are already incapacitated mentally and physically before the fracture. It is argued that there is insufficient evidence to justify surgical treatment in all such patients. Recommendations are made for improving hospital care for proximal femoral fractures in Stockport and alternative strategies for dealing with this difficult health care problem are considered.

The evaluation of health care is a formal process for assessing the efficiency and quality of health care against pre-determined objectives. Implicit in the ideology of evaluation are the ideas that choices about the allocation of scarce health care resources should be made according to criteria which are as explicit and rational as possible, and that, as a result of evaluation, desired change will be implemented. However, in the real world, the evaluation of health care is conceptually complex and methodologically difficult. This thesis uses the example of proximal femoral fractures to consider the problems of applying the ideology of evaluation in practice. A range of techniques for evaluation exists and these vary in the cogency of the evidence they provide. It is suggested that these techniques must be applied selectively and criteria for agreeing priorities for evaluation in health care are discussed. The application of these criteria should ensure that the evaluation of health care is of use in making difficult decisions about the allocation of scarce resources in the rapidly changing real world and in implementing desired change.

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Chapter 1

INTRODUCTION.

Proximal femoral fractures are mainly a problem of elderly people [2] [3]. Owing to demographic changes the total numbers of hospital admissions in England and Wales for proximal femoral fractures have increased in recent years [4]. This increase in hospital admissions has resulted in growing pressure on the acute orthopaedic services [5]. In addition to this pressure on scarce health care resources, prospective studies of outcome have suggested that these fractures cause appreciable mortality and morbidity and associated suffering [6]. Proximal femoral fractures are common and costly, in terms of both the use of scarce health care resources, and morbidity and mortality. For these reasons alone some attempt at evaluation of the outcome of hospital treatment for these fractures is justified.

Quite apart from potential practical benefits consequent upon improvements in efficiency, proximal femoral fractures can serve as an illustrative example in a rather more theoretical consideration of some of the problems of evaluating health care. In this context the example of proximal femoral fractures is relevant to two much broader debates within the domain of evaluation: the health care of elderly people, and technology assessment, including surgical audit.

It has been estimated that in the financial year 1981 to 1982 the provision of services for people aged over 65 years consumed 41 per cent of overall National Health Service expenditure [7].

Furthermore, this proportion has been increasing and it has been estimated that real growth in health care expenditure of about 0.7 per cent per annum is needed to maintain existing services as a result of demographic changes in the proportion of elderly people [8]. Some of these services are provided mainly for elderly and physically handicapped people, for example acute hospital geriatrics, and expenditure on such services increased from 12.4 to 15.5 per cent of total expenditure between 1970 to 1971 and 1983 to 1984. In addition, elderly people are also increasing users of general acute hospital services. For example, Dove and Dave showed that the proportion of all persons attending the accident and emergency department in Nottingham who were aged 70 years and over increased approximately from 6 per cent in 1965 to 8.5 per cent in 1983 [9]. This is particularly true of the orthopaedic service. It has been estimated that the proportion of all orthopaedic beds occupied by patients aged 65 years and over increased from 33 per cent in 1968 to 44 per cent in 1977 [5]. General practice morbidity statistics show that between 1971 to 1972, and 1981 to 1982, the face-to-face consultation rates for people in the age-groups 65 to 74 years, and 75 years and over, increased providing evidence of increased demands for primary medical care associated with demographic changes [10].

Clearly, any attempts to improve the overall efficiency of health care cannot ignore the health care of elderly people. They have health problems and needs for health care which are rather different from those of younger people. Thus because of the increasing importance of health care for elderly people in a quantitative sense and because of qualitative differences in their needs for health care, special consideration needs to be given to the particular problems of evaluating such care. Proximal femoral fractures occur almost exclusively in elderly people and can

conveniently be used as an `index impairment´ to illustrate some of these problems [11].

In general, proximal femoral fractures are treated surgically and in the 130 years since von Langenbeck first attempted internal fixation of a proximal femoral fracture with a metal pin there has been considerable and continuing research into and development of innumerable devices for this purpose [12] [13]. In part this has been because of technical problems in attempting to obtain healing of the intra-capsular type of these fractures and the feeling that, in general, results have been far from satisfactory [14] [15].

In the same way as the proportion of health care expenditure allocated to elderly people has been growing, the proportion spent on technological innovations has also been increasing [16]. It has been estimated that real growth in health care expenditure of about 0.5 per cent per annum is necessary to maintain existing services in the face of changing technology [8]. It has been argued that there has been insufficient evaluation of new treatments and that the economic consequences of such developments were not anticipated [17] [18] [19]. Certainly the pace of technological innovation has been such that new technologies have been implemented before any thorough evaluation of cost-effectiveness as is illustrated, for example, by the introduction of computer assisted tomographic diagnosis [20]. Jennett has suggested that new surgical treatments develop in a stepwise fashion without evaluation and in an attempt to reduce this problem the United States Congress has set up an Office of Technology Assessment [21]. Because of continual technological innovations in the surgical treatment of proximal femoral fractures they again serve as a useful example of some of the problems encountered in attempts to assess new technology and audit surgery.

An important consideration in any attempt at the evaluation of health care is the applicability of the findings. Any study which selects a subset of patients with a given health problem may not provide a representative sample upon which to base conclusions. One technique of evaluation is the case series which is one kind of observational study (as contrasted with intervention studies) [22]. There are many examples of attempts at evaluation based upon hospital series of consecutive patients. One problem with this approach is the difficulty of making empirical generalisations since the size of the hospital catchment population is usually unknown. There is a real possibility that the cases which are seen in a particular hospital have in some way been selected. One way of avoiding such selection bias is to attempt to ascertain all cases of a particular disease occurring in a defined population during a given time period. A typical health district, with a population of about 250,000, arguably provides a suitable population for study.

Another consideration in an observational study is the need to make comparisons between different series of patients so as to draw conclusions about, for example, different treatments or different health professionals. Such comparison depends upon some kind of standardisation of methodology. An unfortunately all too common problem with case series is that the outcome of treatment is assessed after a variable time interval. Such variations can be either within a given series or between different series and the former are particularly difficult from the point of view of comparing the success of treatment in different series. This problem of variable length of follow-up can be minimised either by using statistical manipulation of the data (for example, by using a life table method for estimating survival) or by using a prospective cohort design with assessment of the outcome of treatment after a fixed time interval.

Any evaluation of the outcome of treatment needs to be set in the context of the objectives of such treatment. The outcome can be expressed in terms of reduction of disease as measured by indices of mortality and morbidity, or in terms of improvement in health as measured by health status indices [23]. Morbidity and health status are particularly difficult to measure and any useful evaluation must measure indices which relate to the objectives of treatment. In particular, in the case of proximal femoral fractures indices of walking ability or functional capability are likely to be more relevant measures of outcome than, say, the incidence of late superior segmental collapse of the femoral head. The former are less technical and more subjective and by implication, more difficult to measure reliably.

Finally, there are two other considerations which are relevant to the evaluation of health care. Firstly, evaluation is a costly process, both in terms of time and material resources. Secondly and as a consequence, unless evaluation leads to some kind of rationalisation of treatment it is wasted. Donabedian has argued, for example, that an unsolved problem with quality appraisal or medical audit is the difficulty of changing physicians' behaviour [24]. Also, policy decisions in the health care domain may of necessity be based on priorities which have been decided as much through a political process of bargaining between different vested interests as by rational consideration.

The present study, which was conducted with very limited resources, was a prospective, observational, cohort study of all cases of proximal femoral fracture occurring in persons usually resident in Stockport between 1 March, 1984 and 31 August, 1985. In addition, trends in national hospital statistics for this condition were examined and the accuracy of such statistics in Stockport was assessed.

1.1 THE OBJECTIVES OF THE STUDY.

The objectives of the study were as follows:

1. To evaluate the outcome of hospital treatment for proximal femoral fractures in the population of Stockport in terms of both mortality and morbidity after a time interval of 6 months (182 days). In particular, an attempt was made to assess morbidity in terms of functional capability.

2. To use proximal femoral fractures as an illustration of some of the problems involved in surgical audit, technology assessment and the evaluation of the health care of elderly people.

3. To make, within the limits of the study design, recommendations about the present treatment of proximal femoral fractures in Stockport.

4. To make some suggestions about future studies in an attempt to reduce the problem of proximal femoral fractures in elderly people.

Chapter 2

BACKGROUND TO THE STUDY.

2.1 THE EPIDEMIOLOGY OF PROXIMAL FEMORAL FRACTURES.

The author has recently reviewed the epidemiology, classification, aetiology and the prospects for prevention of proximal femoral fractures [3]. The incidence of these fractures increases approximately exponentially with age from the fourth decade of life in both men and women. The rate of this exponential increase is greater in women than in men; below the age of about 45 years male incidence rates are higher but beyond this age female rates exceed the male rates. The incidence of proximal femoral fractures appears to vary between different populations and appears to be lower in black than in white people. In people aged 65 years and over, most fractures are associated with falls, mainly in the home. Extrinsic environmental factors appear to be less important in causing falls than the intrinsic susceptibility to falling which appears to be an inevitable consequence of growing old. Although most proximal femoral fractures are associated with falls, evidence from community studies suggests that only a minority of falls result in fractures. The liability to suffer a fracture during a fall increases with extreme old age. The fractures are principally classified according to an anatomic axis of classification into intra-capsular and extra-capsular (trochanteric) fractures.

2.2 STOCKPORT AND ITS HOSPITAL SERVICES.

The earliest historical reference to Stockport is in the Chronicle of Benedict of Peterborough. He referred to Stockport castle which had been successfully held against the forces of Henry II in the rebellion of 1172. In about 1220, the then Earl of Chester, Randle III granted a charter of freedom to his baron Sir Robert de Stokeport. This charter conferred privileges on the borough, for example to hold a weekly market and an annual fair and it formed the basis for local government.

In the succeeding centuries, Stockport became an important trading centre and by the beginning of the eighteenth century had become a market town which housed some of the landed gentry of Cheshire and which was noted for the beautiful countryside nearby. At this time the population was about 2,000 inhabitants and the town occupied about 1,500 acres. The manufacture of hemp had started in the town in the sixteenth century and between about 1700 and 1800 the population increased from about 2,000 to 14,000 people. This growth in population occurred largely in association with the growth of the silk industry. With the rapid development of the cotton industry in the early part of the nineteenth century, the population grew to 44,666 in the 1830s. Until that time the town had been governed by the Court Leet and its officers. The scavengers, for example, ensured that the streets were kept clean. The Municipal Corporations Act (1835) empowered the burgesses to elect a town council.

In 1889, Stockport became a county borough which was subsequently extended in the present century by the addition of Reddish, Cheadle, Heaton Norris, Hazel Grove and Brinnington. Since

the end of the second world war, the textile manufacturing industry has virtually disappeared and has been partially replaced by engineering and science based industry. By 1976 some 34 per cent of the population were employed in administrative and technical jobs with many people travelling to work outside Stockport. In 1974, with local government reorganisation, Stockport became a metropolitan borough in the metropolitan county of Greater Manchester. The geographical boundaries of Stockport metropolitan borough and Stockport health district are coterminous.

Table 1 summarises data from the 1981 Census in England and Wales [25]. The table compares the distribution by age for both sexes combined of the population present on census night for Stockport and England and Wales. The population of Stockport in all age-groups beyond aged 55 years, when expressed as a proportion of the total Stockport population, is lower than the corresponding proportion for England and Wales. In other words, the Stockport population is, on average, slightly younger than the population of England and Wales as a whole.

TABLE 1.

POPULATION PRESENT ON CENSUS NIGHT - 1981 CENSUS.

AGE-GROUP (YEARS)	ENGLAND AND WALES. PERSONS PRESENT	ENGLAND AND WALES. PER CENT	STOCKPORT. PERSONS PRESENT	STOCKPORT. PER CENT
0-4	2948253	6.00	17405	5.99
5-15	7928425	16.13	48429	16.68
16-24	6934027	14.11	39302	13.53
25-34	7016621	14.27	41942	14.44
35-44	5907336	12.02	36580	12.60
45-54	5491424	11.17	33599	11.57
55-59	2901886	5.90	16977	5.85
60-64	2569564	5.23	14326	4.93
65-69	2475148	5.04	13794	4.75
70-74	2109406	4.29	11953	4.12
75-79	1496807	3.05	8549	2.94
80-84	847985	1.73	4666	1.61
85 +	527805	1.07	2900	1.00
TOTAL	49154687	100.00	290422	100.00

Table 2 also summarises data from the 1981 Census [25]. The table compares the social class distribution of economically active heads of private households for the usually resident population of Stockport and England and Wales. In general, the Stockport population is of a higher social class than the general population of England and Wales.

TABLE 2.

SOCIAL CLASS OF ECONOMICALLY ACTIVE HEADS OF PRIVATE HOUSEHOLDS FOR THE USUALLY RESIDENT POPULATION - 1981 CENSUS.

SOCIAL CLASS OF ECONOMICALLY ACTIVE HEADS OF HOUSEHOLD	ENGLAND AND WALES		STOCKPORT	
	HOUSEHOLDS	PER CENT	HOUSEHOLDS	PER CENT
I	68548	5.96	646	8.96
II	296173	25.77	2250	31.20
III(N)	160912	14.00	1115	15.46
III(M)	374780	32.61	2112	29.28
IV	187782	16.34	830	11.51
V	61132	5.32	259	3.59
TOTAL	1149327	100.00	7212	100.00

Hospital services in Stockport developed in a similar way to other English towns. The first cottage dispensary was opened in Churchgate in 1724. However, a need was felt for hospital beds to provide in-patient services for surgical treatment and for fever cases. The first hospital in the town was Stockport Infirmary, a voluntary hospital situated near to the town centre. The foundation stone was laid in 1832 and the first patients were admitted in 1834. The hospital was subsequently enlarged in 1870, 1885 and 1898. Other hospitals were opened at sites further away from the town centre, of which the most important is Stepping Hill hospital, which was opened in 1905 by the Stockport Union. This hospital is now the district general hospital.

Acute orthopaedic and trauma services are, at present, provided at Stockport Infirmary. There are about 80 acute orthopaedic beds

divided between 4 wards, 2 female and 2 of which are largely male. There are busy radiological and casualty departments in the hospital and an operating theatre. Most other acute hospital services are based at Stepping Hill Hospital which is over 2 miles away from the Infirmary. In addition, there are another 34 orthopaedic beds which are used for elective orthopaedic surgery, for example hip replacements, at the Devonshire Royal Infirmary which is in Buxton. Although this hospital is situated geographically in the North Derbyshire health district, it is managed by Stockport Health Authority. Primary surgical treatment of patients with acute proximal femoral fractures takes place at Stockport Infirmary.

At Stockport Infirmary there are 5 consultant orthopaedic surgeons and 7 junior orthopaedic medical staff. There are 65 whole-time equivalents of nursing staff on the acute orthopaedic wards, 2 whole-time equivalents of physiotherapy staff, a social worker is based at the hospital and occupational therapists are available when needed.

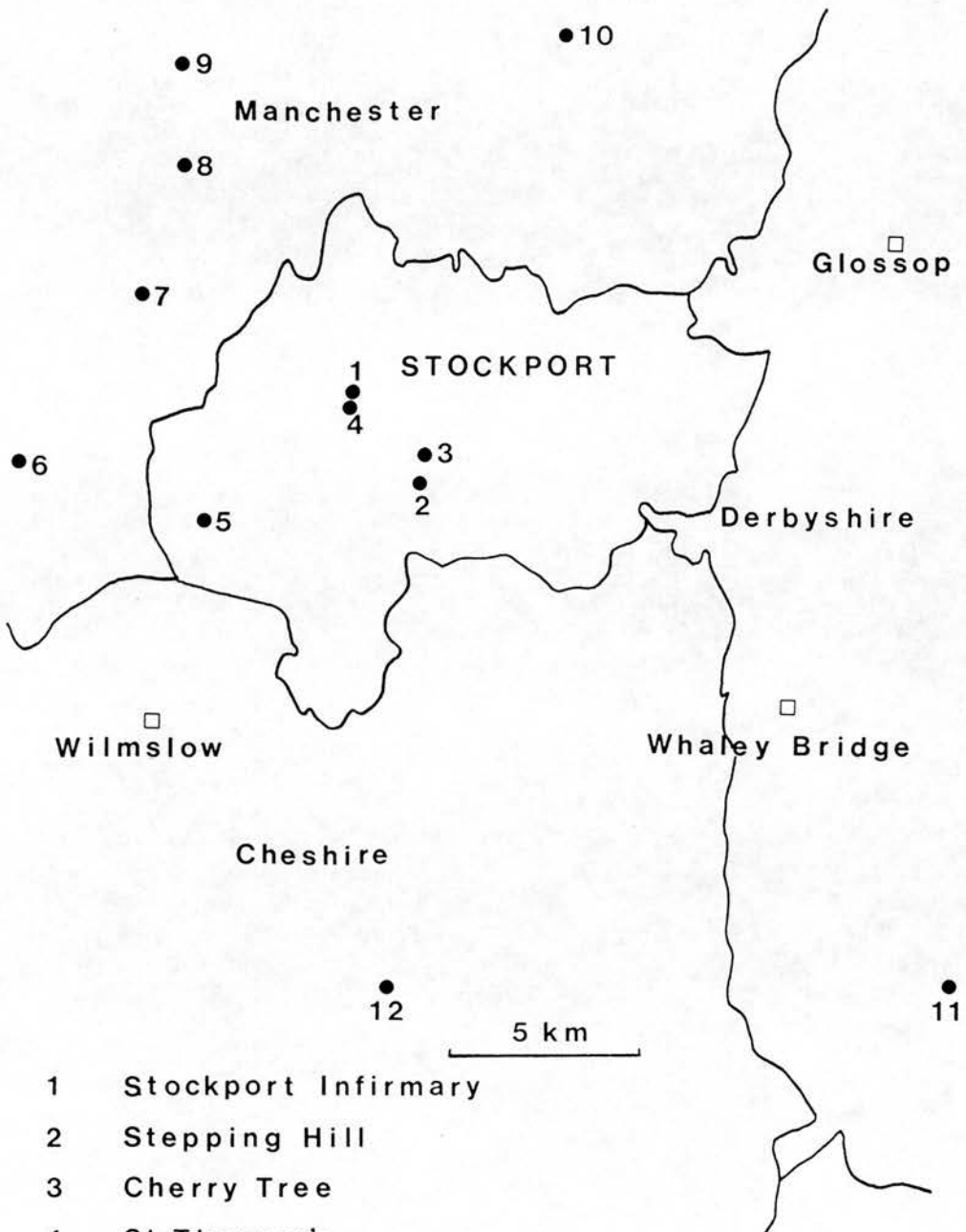
The orthopaedic surgeons collaborate with geriatricians and anaesthetists in the care of elderly people with proximal femoral fractures, although there are problems in obtaining geriatric and anaesthetic opinions because of the scattered provision of services at different sites. At the time of the study there was no regular ward round by a geriatrician on the acute orthopaedic wards. There is an orthopaedic rehabilitation ward of 17 female beds at Cherry Tree Hospital which is about 2 miles from the Infirmary. These beds are used almost exclusively for the rehabilitation of patients with proximal femoral fractures. Hospital Costs Statistics show that, in the financial year ending in March 1984, the average cost per in-patient day for patient care and general services at Stockport Infirmary was 87 pounds.

Stockport is surrounded by the adjacent health districts of North Manchester, Central Manchester, South Manchester, Macclesfield, North Derbyshire and Tameside and Glossop. Patients from the South-West of the borough have tended to regard Wythenshawe Hospital in South Manchester district as their local hospital and some patients are referred to the teaching hospital, Manchester Royal Infirmary, in Central Manchester District.

There are 2 private hospitals in Stockport : Cheadle Royal Hospital (340 beds) is a private mental illness hospital and the Alexandra Hospital (149 beds) in Cheadle is a private general hospital. Orthopaedic surgeons operate at the Alexandra hospital but primary treatment of proximal femoral fractures at this hospital is very uncommon.

Figure 1 is a map showing the distribution of hospital services in the Stockport locality.

FIG 1



1 Stockport Infirmary
2 Stepping Hill
3 Cherry Tree
4 St Thomas's
5 Cheadle Royal
6 Wythenshawe
7 Withington
8 Manchester Royal
9 Ancoats
10 Tameside DGH
11 Devonshire Royal
12 Macclesfield DGH

2.3 THE SURGICAL MANAGEMENT OF PROXIMAL FEMORAL FRACTURES: HISTORICAL DEVELOPMENT.

In a historical context, the treatment of fractures in general has largely been bound up with the history of wars and human conflict. The principles of fracture management can be traced back many millenia. For example, Egyptian mummies have been found dating from the fifth dynasty, about 2750 - 2625 B.C., with fractured limbs bound in splints which were probably used in life [12]. The first recorded use of a crutch is believed to be a carving executed in 2830 B.C. on the entrance of a portal in Hirkouf´s tomb. Medical practice existed in the great Graeco-Roman civilisations from about the time of Homer and accurate anatomical observations dating to the time of Herophilus (third century B.C.) suggest that human dissection was practised at this time. Hegetor of Alexandria recorded in 100 B.C. a description of the anatomical relations of the hip joint.

Our knowledge of early Graeco-Roman medical practice comes from the `Corpus Hippocrates´, a group of books written between the fourth century B.C. and the first century A.D. Hippocrates of Cos died in about 370 B.C. and the book on fractures provides clear evidence of the use of traction for the reduction of fractures. The fractured limbs were bound with bandages, splints and fracture troughs and the bandages were sometimes reinforced with clay and starch mixtures which were similar in principle to Plaster of Paris. At this time it was well recognised that muscular inactivity led to weakness and wasting and that exercise strengthened the body. Pressure sores were a recognised complication of immobility and attempts were made to prevent these through the use of padding.

Wine was applied to wounds and this could be considered the first use of the principle of antisepsis [12].

The first recorded prosthesis is believed to be a wooden leg dating to about 300 B.C. found in Capua in southern Italy. Antyllus used linen and catgut sutures during the third century A.D. and during this period a variety of surgical instruments, including bone drills, saws and ostial elevators, was used. On the other side of the world in India, fractures were described in the Ajur-Veda of Susruta, together with the diagnostic sign of crepitus and the use of splints and sutures. It is, therefore, quite clear that the treatment of fractures was established practice in these early times, although, because of the shorter life span of the population, it is unlikely that proximal femoral fractures were the problem that they are today [12].

In Paris during the sixteenth century the guild of barber surgeons emerged and one of these, Ambroise Paré, was the first specifically to describe a hip fracture. The seventeenth century saw the birth of the modern `social sciences´, i.e. social problems began to be seen more as a community responsibility. The first Poor Relief Act in England in 1601 mentioned the `cripple´ and attempted to provide for his care. The speciality of orthopaedics developed from general surgery in the eighteenth century in response to social concern about the plight of crippled children. The word orthopaedics (`straight child´) was coined by Nicholas André, professor of medicine in Paris, who wrote a treatise entitled `Orthopaedia´ [26]. At this time the speciality was particularly concerned to treat childhood deformities in the hope of preventing crippling consequences during adult life. The main preoccupations were spinal deformities which were attributed to poor posture, Pott´s disease (tuberculosis) and rickets [12].

Astley Cooper in the nineteenth century was the first to attempt to classify hip fractures into intra-capsular (within the joint capsule) and extra-capsular [27]. He recognised the poor outcome of intra-capsular fractures and commented on the permanent lameness, the crepitus, the shortening and the deformity which were the consequences of a failure of bone union following these fractures. Before the time of Sir Astley Cooper, surgeons had tried various splinting devices and extension methods in an attempt to produce bone union in such fractures [28]. Sir Astley Cooper commented that since bony union did not occur despite such methods, which could even be harmful, the best treatment for intra-capsular fractures was conservative and he merely placed pillows under the affected limb. Since he also recognised that prolonged immobility could be harmful to elderly people, he stressed the need for early mobilisation on crutches as soon as the `pain and inflammation´ had subsided, usually within 10 - 14 days following the fracture.

Other practitioners continued to try various closed methods of reduction, splinting and applying traction in an attempt to improve the outcome of intra-capsular fractures. Internal fixation using a metal nail was first used in 1858 by von Langenbeck [12]. The next major development in the management of proximal femoral fractures was the discovery in 1895 of X rays by Röntgen [29]. This made possible the accurate visualisation of fractures and improved their classification on an anatomical axis.

By this time the cardinal principles of fracture management, namely accurate reduction of the fragments and stable fixation had been established. The introduction of diagnostic radiology revealed the problems of obtaining satisfactory reduction and secure fixation of intra-capsular fractures. Royal Whitman considered the anatomy of the proximal femur and in 1902 reported on a new method of treatment in which reduction was attempted by a combination of

abduction, internal rotation and traction. A plaster spica was applied from the nipples to the toes of the fractured limb in order to fix the reduced fracture with the lower limb held in internal rotation and abduction [30].

Radiology also demonstrated the frequent failure of bony union in intra-capsular fractures and the late problem of superior segmental collapse of the femoral head. This latter problem was attributed to an interruption of the vascular supply to the head of the femur during the fracture. Many other problems were attributed to inadequate mechanical fixation of the fracture and in 1931 Smith-Petersen reported on the use of a trifin metallic nail which was designed to prevent the capital fragment from rotating on the cervical fragment [31]. This operation originally involved an extensive arthrotomy but in 1936 a `blind nailing´ technique was developed in which the nail was introduced through an incision over the greater trochanter under radiographic control.

Internal fixation became the preferred treatment for intra-capsular fractures, although until quite recently there has been much debate about the need for internal fixation of `impacted´ sub-capital fractures - see, for example, [32]. Despite many modifications and technical developments, the results of internal fixation of intra-capsular fractures remained far from satisfactory. By the mid-1940s it was recognised that the Smith-Petersen nail often failed to provide fixation of the fracture and attempts were made to improve the technique of nailing by siting the nail at a lower angle with the head and neck of the femur.

Garden studied the trabecular pattern of the cancellous bone in the proximal femur - `the internal weight bearing system´ - which he felt provided a guide to the mechanical forces acting upon this bone during weight bearing [33]. He felt that a device such as the low

angle nail, placed in a more vertical position than the Smith-Petersen nail, would provide more stable fixation and permit earlier weight bearing. Garden also used the trabecular pattern of the proximal femur as a guide to the degree of displacement of sub-capital proximal femoral fractures. He then classified these fractures into 4 stages of displacement as a guide to methods of reduction. He pointed out that the problems of non-union were largely confined to the fully displaced stage IV fractures. These were the most difficult fractures to reduce satisfactorily. Garden felt that by 1970 most of the devices used for internal fixation were adequate and that further improvements in the outcome of treatment would depend upon achieving more satisfactory reduction of the fracture before fixation [34].

At the present time the preferred method of internal fixation of extra-capsular proximal femoral fractures is the dynamic hip screw and intra-capsular fractures are treated either by low friction arthroplasty, hemi-arthroplasty or by internal fixation with, for example, Garden screws depending upon the degree of displacement and the surgeon´s preference [35] [36].

Chapter 3

REVIEW OF THE LITERATURE: EVALUATION AND HEALTH CARE.

Evaluation is a broad concept and it would not be possible to produce a comprehensive literature review of all aspects of the evaluation of health care. This review will concentrate on the more recent literature and on some of the conceptual problems and practical difficulties which complicate attempts to evaluate health care.

3.1 THE RATIONALE OF EVALUATION.

One of the problems in attempting to provide a balanced account of the role of evaluation in health care is finding agreement about the meaning and proper use of the different technical terms involved. The terminology has all too often been used loosely and indiscriminately and even authorities in the field may be unable to reach complete agreement about some definitions.

The World Health Organisation has defined evaluation as:

> "the systematic and scientific process of determining the extent to which an action or set of actions was successful in the achievement of predetermined objectives [37]."

Holland has suggested a slightly more specific definition:

> "the formal determination of the effectiveness, efficiency, acceptability, and safety of a planned intervention or programme in achieving stated objectives [38]."

Implicit in these definitions are the ideas that the evaluation of health care must relate to the objectives and that the process of evaluation should in some sense be objective and impartial.

The major reason for the current interest in the evaluation of health care is the realisation that resources for health care are `scarce´ in an economic sense [39]. For example, in the United Kingdom the proportion of gross domestic product spent on health care increased from 3.9 per cent in 1960 to 5.9 per cent in 1982 and this trend has occurred in all the major industrial nations [40]. Resources are finite and choices need to be made about their allocation [41]. Decisions about the allocation of scarce resources are made according to criteria which can be either implicit or explicit. It is argued that explicit criteria are preferable [42]. If the decision making process is formalised according to explicit criteria then justice is not only done but can be seen to be done [43]. Decisions which are socially unacceptable can be challenged and the allocation of resources will more truly reflect societal preference. As a result of evaluation, scarce resources will be used in the most efficient and equitable way. Furthermore, the process of evaluating health care is necessary to ensure that the objectives of the different health care interventions are achieved.

This preoccupation with the scarcity of resources has led to attempts to measure and improve the `efficiency´ of health care so as to obtain `value for money´. Efficiency is a concept which relates the resource inputs to health outcomes [44]. An efficient

health care process is one which maximises the health outcomes from a given input of resources.

Although resource constraints have been a major factor in the continued interest in evaluation, it should not be forgotten that another reason for attempting to evaluate health care is to improve the `quality´ of care. The 1946 National Health Service Act in Great Britain was a commitment to provide good quality health care. More recently, the World Health Organisation´s European Regional Office has suggested 38 targets for achievement by the year 2,000, one of which is:

> "By 1990, all member states should have built effective mechanisms for ensuring quality of patient care within their health care systems [45]."

The report of the National Health Service Management Inquiry suggested that there was a need for the continuous evaluation of the performance of the National Health Service in providing a quality product [46]. There is, therefore, a general acceptance that health care should achieve certain standards of quality and that the concept of evaluation ought to include the assessment of quality of care. The terms `medical audit´ and `quality appraisal´ have been used to describe the systematic assessment of the quality of medical care, usually by the doctors involved, according to pre-determined criteria or standards. Maxwell has suggested that quality can be thought of as comprising six dimensions: access to services, relevance to community need, effectiveness, equity, social acceptability and efficiency [47]. Cochrane has defined an effective process as being one which favourably alters the natural history of disease [17]. In other words, an effective health care intervention will produce a favourable health outcome. An efficient health care intervention is one which maximises the health outcomes obtained

from a finite input of health care resources. Since an ineffective health care intervention does not produce favourable health outcomes, it is obvious that an ineffective process cannot be efficient. However, the concept of efficiency requires more than effectiveness: it is necessary that the best use be made of finite health care resources, in other words, that these resources are committed to those processes which produce maximum health outcomes.

The methodology of evaluation would ideally be robust and valid. Validity has been thought of as including face validity, i.e. whether a measurement actually measures what it purports to measure and content validity, i.e. whether all relevant components are included in the measurement process [38]. The process can either be an ad hoc process which periodically examines selected health care interventions or a continuous process of monitoring or audit. In an ideal world, evaluation would be cheap, continuous and quick in terms of time and would be comprehensive and reliable in terms of content. It would consider both the quality of care through an assessment of the structure, process and outcomes of health care, and the efficiency by determining which health care processes maximised the health outcomes for given resource inputs [48] [17]. Furthermore, as a result of evaluation decisions would be taken and change implemented.

Implicit in the concept of evaluation is the ideology that decisions about the allocation of scarce resources to improve the health or quality of life of society in general should be made rationally.

3.2 PRACTICAL PROBLEMS OF EVALUATION.

In the real world several factors complicate attempts to apply the ideology of evaluation in practice.

3.2.1 PROBLEMS OF MEASUREMENT.

The assessment of the efficiency of health care involves an attempt at the enumeration, measurement and valuation of both costs and outcomes [44]. Measurement of inputs needs to consider direct costs which can be either fixed overheads or variable costs. Fixed overheads include such items as the costs of heating and lighting a hospital ward. These costs remain the same while the ward is open regardless of patient turnover or bed occupancy rates. The variable costs relate to items which may be specific to particular patients, for example, the costs of selective diagnostic procedures. In addition to the direct costs, there is a need to consider indirect costs. For example, one of the indirect costs of care `in the community´ might be loss of productivity owing to the need for a key carer to give up paid employment. Other costs known as intangible costs recognise the importance of, for example, the side-effects of treatment in making a patient feel unwell. Furthermore, it is necessary to ask the right costing question and to consider not just average unit costs, but the opportunity cost [49]. The concept of the opportunity cost of any activity refers to the value of the resources consumed in their best alternative use. It recognises that wrong choices can be costly since scarce resources are wasted. With complex or long term health care interventions or programmes it can be difficult to enumerate, measure and value such costs and this is particularly true of the indirect and intangible costs.

The problems of enumerating, measuring and valuing the health outcomes are even greater. A major difficulty is uncertainty about the natural history of disease processes. This uncertainty exists because it is rare for diseases to remain untreated once they have been diagnosed, even though the treatments themselves may have been imperfectly evaluated. Clearly, if there is uncertainty about the natural outcome of a particular disease it can be impossible to be sure that any particular health care intervention has improved upon the natural outcome.

In general, health outcomes are measured in terms of reduced ill health, measured as either mortality or morbidity, or more recently, improved health status. Because of the difficulty in quantifying such concepts the emphasis has shifted from cost-benefit analysis, in which both costs and benefits are expressed in terms of money, to cost-effectiveness analysis, in which the costs of alternative inputs to achieve the same health outcome are compared, to cost-utility analysis [50]. Utility is a concept of economic theory which refers to a common measure of the satisfaction obtained from all consumption [51]. Various measures or indices of health status have been developed in an attempt to allow not only for mortality, but for `quality of life´. Such indices attempt to measure variations in distress and disability associated with different health states and inevitably involve a large subjective component.

Donabedian has suggested that the assessment of the quality of health care should consider the structure, the process and the health outcomes [48]. Quality in health care is, however, a rather nebulous concept. It is clear that quality requires an investment of health care resources and if there are resource constraints there is a potential conflict between attempts to maximise quality and attempts to ration health care. Quality is, therefore, a relative

rather than an absolute concept. Since quality of care is a relative concept it should be assessed against pre-determined standards. These standards should include both the technical and inter-personal aspects of the interaction between the health care provider and the consumer. A major issue in the evaluation of health care concerns the question: who should set these standards and monitor the extent to which they are attained? It has been argued that it is preferable for the health care professionals to agree these standards and to monitor the quality of the service [52]. Since a major objective of audit is to produce desired changes in clinical behaviour and this can only be done through education, it is necessary that audit be acceptable to doctors. It is argued that the best way of ensuring that audit is acceptable is to allow the professionals to agree the standards by which quality is to be judged and to do the auditing themselves.

Some of the dimensions suggested by Maxwell, such as relevance to community need and social acceptability are inevitably somewhat subjective and by implication, difficult to measure. They imply that society in general has a legitimate interest in health care and that the assessment of quality should include the consumers' viewpoint. It can be difficult to incorporate societal preferences into a formal process of measurement. A further problem is that attempts to improve different aspects of the quality of health care may be mutually conflicting. Attempts to achieve the most efficient health care according to utilitarian principles (maximising social welfare) may conflict with attempts to improve equity. For example, because of economies of scale, it may be more cost-effective to concentrate expertise in managing rare conditions in a few centres but this will inevitably reduce the access to such care for people living in more remote areas. Such potential conflict between different aspects of quality of care implies the need for agreement

about social priorities. Such agreement can be difficult to obtain.

The subjective element in all these factors creates considerable problems of measurement. The ideal instrument of measurement would be valid and reliable. Reliability requires that the same instrument would give consistent results when measurements are repeated. The validation of various instruments for measuring subjective phenomena is in itself a complex and time consuming activity [53].

3.2.2 BIOLOGICAL VARIATION AND ITS IMPLICATIONS FOR METHODOLOGY.

Measurements of biological phenomena inevitably are subject to different types of variation. This can be between different observers, for the same observer at different times, between different subjects and for the same subject at different times. Such variation needs to be accounted for in any empirical deduction and it imposes constraints upon the design of studies. In addition, in the real world there are subtle sources of bias which also need to be considered.

It has been suggested that there is a hierarchy of study designs with respect to the cogency of the evidence that they provide about the effectiveness of health care [54]. Observational studies rank lower than intervention studies. Observational studies include, in increasing rank order, individual case reports, and cohort studies which may be either uncontrolled or controlled series of consecutive hospital cases. Intervention studies test the effectiveness of a given health care process in a planned experiment, which may be either uncontrolled or controlled. The most cogent evidence is provided by the randomised, controlled trial which deals with the problem of biological variation and possible

confounding variables. Differences between the intervention and control group in unknown variables which may have an independent effect on outcome should in the long run cancel each other out so that there should be no bias. If such an experiment is designed with due consideration of the laws of probability then the conclusions of such an experiment should have the force of logical consequences of those laws [55].

Nevertheless, it has been argued that the randomised, controlled trial is not always appropriate in the real world [56]. Dudley postulates that:

> "there is a continuous rather than a discontinuous scale of reliability not a quantum leap from none to near total reliability and that the place of the controlled trial in clinical medicine must be assessed against that scale . . . Provided that we are aware of the reliability of the knowledge we intend to use in any situation, we are not debarred from incorporating it in our decisions."

Although there is, therefore, some debate about the place of the randomised controlled trial in the advance of knowledge, there is virtually no argument that resources are scarce and that the randomised controlled trial can be costly both in terms of time and money. A recent example was the multiple risk factor intervention trial in the United States which was costly and inconclusive [57] [58].

Clearly there is a dilemma between the need to make `correct´ decisions and the need to make rapid decisions. There needs to be a balance or `trade-off´ between what is feasible and realistic on the one hand, and what is ideal or desirable on the other.

3.2.3 RAPID CHANGES IN THE ENVIRONMENT.

The health care systems of modern industrial countries operate in a rapidly changing environment and of particular relevance are changes in demographic structure, technological innovation and changing disease patterns.

3.2.3.1 CHANGES IN DEMOGRAPHIC STRUCTURE.

Changes in the age structure of the population have considerable implications for health care. Of particular importance is the increasing proportion of elderly people in the population. For example, comparison of the findings of the censuses of 1971 and 1981 in Great Britain reveals that there was a growth of 10 per cent in the population of pensionable age and an even greater growth of 24 per cent in the population aged 75 years and over. There was a concomitant decline in the numbers of the population not of pensionable age of 1 per cent [59]. This increase in the proportion of elderly people has occurred because of changes in fertility and in life expectancy and of particular importance in health care terms has been the increase in life expectancy of the older age-groups in recent years. This increase in the proportion of those in the oldest age-groups is projected to continue but unexpected reductions in mortality in these age-groups indicate the need for caution in forecasting future population changes [60]. Alderson and Ashwood have recently discussed possible refinements of the process of population projection by considering age specific mortality rates for the major causes of death and the likely effect of changes in health affecting behaviour such as cigarette smoking [61].

There has been considerable debate about the implications for future morbidity of these demographic changes. Fries postulated

that there would be `compression of morbidity´ and `rectangularisation´ of survival curves [62]. He argued that the length of the human life span was fixed, that chronic disease could be postponed and he deduced from these premises that:

> "the time between birth and first permanent infirmity must increase and that the average period of infirmity must decrease."

Thus although more people would survive into old age, infirmity would be postponed and because of the biological limit to the life span most people would die within a relatively short time interval at the end of natural life span resulting in a steep decline or rectangularisation of the survival curve in the oldest age-groups. This optimistic scenario about future morbidity has been firmly rejected by other gerontologists who argue that there is no evidence to date of a fixed life span since mortality rates even at the oldest ages in the United States are still declining [63] [64] [65]. Alderson has recently considered trends in England and Wales in population, mortality and morbidity statistics and has concluded that we cannot reliably predict future morbidity in elderly people [66].

3.2.3.2 TECHNOLOGICAL INNOVATION.

In the broadest sense, including new pharmacological treatments, new technical equipment and new surgical procedures, medical technology has been developing at an accelerating pace. These technologies can be extremely expensive. For example, it was recently estimated that one procedure, coronary artery bypass grafting, consumed approximately 3 per cent of the United States health service revenue [67]. The evidence suggests that such technological innovations are implemented in practice without

adequate evaluation. This is illustrated by the purchase of computerised tomographic imaging equipment in the United States in an uncoordinated manner [20]. Such technological innovations may increase the bounds of medical possibility so that, for example, it becomes possible to prolong and improve the quality of life of patients with end-stage renal disease. Other innovations in medical treatment seem less effective despite widespread implementation. While it is undoubtedly true that innovations in the treatment of, for example, established malignant disease of the female breast have resulted in a reduction in the frequency of mutilating operations such as radical mastectomy, for other common malignant diseases the results of therapeutic innovations have not been spectacular. Bailar has argued that mortality rates for some of the commonest cancers have not changed [68]. He has argued that the answer to the problems of bronchial carcinoma, for example, lies in prevention through a reduction in cigarette smoking. Although technological innovations may improve the quality of life of patients with established malignant disease, they are no substitute for preventive measures.

3.2.3.3 CHANGING DISEASE PATTERNS.

Since social factors are inevitably related to the frequency of disease, rapid social changes will affect patterns of disease in the population. Powles cites the example of coronary artery disease as a disease of maladaptation of modern civilisations [69]. The most dramatic example of changing disease patterns is infection with the human immunodeficiency virus with implications in all aspects of human experience [70].

The implication of these rapid changes in the environment within which health care operates is that decisions about the allocation of resources need to be taken in the absence of complete

information. The faster the rate of change, the greater the problem. The ideology of evaluation requires a formal methodology which is not easy to reconcile with the need to make decisions sufficiently rapidly to keep pace with social change.

3.2.4 THE COMPLEXITY OF THE NATIONAL HEALTH SERVICE.

Klein has argued that the British National Health Service is organisationally complex and conceptually perplexing and that these factors create difficulties in attempts to evaluate performance [71]. Structurally the National Health Service is large and hierarchical and there are multiple vested interests including the health care professionals, the employees, the patients, the health authority, the government and so on. In addition to these structural difficulties there are also conceptual problems, not the least of which is the problem of agreeing the objectives of the service. To paraphrase Seneca, if a man does not know which harbour he is making for, no wind is set fair. The health service may have multiple objectives including the prevention, treatment and cure of disease and the care of people with chronic disabilities, together with health promotion. A major aim of the process of evaluating health care is to ascertain the extent to which these pluralistic objectives are achieved. Such pluralism obviously complicates attempts at evaluation. The control of health involves activities at different levels of prevention and some kind of balanced provision of resources needs to be agreed [72].

It has been argued that no-one takes decisions in the National Health Service and that:

> "if Florence Nightingale were carrying her lamp through the corridors of the NHS today she would almost certainly be searching for the people in charge [46]."

Klein suggests that when everyone in the service is a decision maker, then, paradoxically, no-one is [73]. He also suggests that the National Health Service represents an attempt to square two circles: central financial responsibility versus delegation of authority, and public accountability versus professional autonomy [71].

Having considered the problem of who makes decisions, there is also the conceptual problem of how such decisions are made. Several different criteria might apply in deciding priorities for the allocation of resources including: welfare maximisation, medical need, merit, partiality, lottery and social worth [43]. No single criterion takes absolute precedence although again decisions may be taken about priorities. This may depend upon the basic model of health care: decisions taken according to a social equity model might be different from decisions taken according to a market model [71]. There may be a trade-off between efficiency and equity and again, a balance needs to be achieved [74].

The implication of the organisational complexity and conceptual perplexity is that there is a need to consult widely in making decisions about the allocation of resources within the health care system. Such consultation takes time and there is, therefore, a built in inertia to change in the health service.

3.2.5 THE HEALTH/HEALTH CARE DEBATE.

Another problem in the practical application of the ideology of evaluation is that health care is not the only determinant of health [75]. Study of trends in mortality rates for selected conditions suggests that these started falling long before specific health care interventions became available, probably due to factors such as improved nutrition, improved housing and improved sanitation. More

recently there has been much debate about the role of inequalities in socio-economic status in causing inequalities in health [76].

The implication for evaluation of the fact that decisions taken in deciding for example housing policy, educational policy and social welfare provision may impinge on health, is that if the overall objective of health and welfare policy is to improve quality of life in general, evaluation which concentrates only on the health service may be incomplete. For example, there is little point in evaluating alternative treatment programmes for alcoholism if changes in fiscal policy increase consumption of alcohol and the prevalence of the problem.

3.2.6 THE PROBLEM OF ACHIEVING CHANGE IN PROFESSIONAL BEHAVIOUR.

Finally, the most important difficulty in applying the ideology of the evaluation of health care in practice is probably that of changing the behaviour of health professionals. Implicit in the ideology of evaluation is the idea that having conducted an evaluation of a particular aspect of health care, desired change will be implemented. The implementation of change following an evaluative exercise has been referred to by some authors as `closing the loop´ in the cycle of evaluation [52] [77] [78]. Donabedian has argued that the failure to close this loop has been the biggest disappointment with attempts to introduce audit or quality appraisal in the United States of America [24].

In 1972, Professional Standards Review Organisations were established by law in an attempt to set up a national system for reviewing the utilisation of scarce health care resources. It has been suggested that from the very beginning, there was intense public debate about whether the main objective of PSROs was cost-containment or quality improvement [79]. Approximately one

third of health service revenue in the United States is financed from public expenditure in the form of the Medicare and Medicaid programmes. The PSROs were set up to review this public sector health care. The major problems with PSROs were that they were costly, and that, because they appeared to be concerned more with cost containment than improving quality of care, they were threatening and unacceptable to health care professionals. For this reason the professionals did not accept the standards used for evaluation and did not cooperate in attempts to change their behaviour.

In an attempt to overcome some of these problems in the United States of America, these PSROs are being replaced by `Peer Review Organisations´ which must include substantial physician representation. These organisations are intended to review hospital admissions and quality of care under the Medicare programme. The 1983 Deficit Reduction Act required a system of prospective payments for Medicare patients based upon predetermined prices for 467 different `diagnosis-related groups´. The PROs have set objectives which are intended to improve the efficiency of hospital care by, for example, reducing admissions for procedures which can safely be done on an out-patient basis or reducing unnecessary ancillary services, and to improve the quality of care by, for example, reducing `avoidable´ deaths. In order to monitor whether or not such objectives have been achieved, it has been necessary to set targets, for example targets for unnecessary surgery. Scepticism about the validity of some of these targets has meant that physicians are unhappy about PROs and this kind of `external´ audit [79].

It has been suggested that centrally imposed audit is misconceived because of the lack of validated standards and because physicians would be unlikely to cooperate, to learn, and therefore

to change their behaviour [52]. There have been several relatively successful attempts to monitor the performance of doctors in achieving quality of care in Great Britain. One way of improving the likelihood that doctors will cooperate in such audit is to guarantee confidentiality. The confidential enquiry into maternal deaths has been reporting nationally for many years and more recently, confidential inquiries into neonatal deaths have been established [80]. An experienced consultant paediatrician acted as an independent auditor and 38 out of 154 potentially viable infants were judged to have died `avoidable deaths´. It was felt that inadequate attention to standard care made a more important contribution to these avoidable deaths than shortages of technological resources. This study was felt to have had an important educational effect on the staff involved. Another recent example of this kind of confidential inquiry into avoidable deaths has been a study set up in 3 health regions: South Western, North East Thames, and Northern, into perioperative deaths [81].

There have been several attempts to improve doctors´ use of diagnostic tests so as to eliminate `unnecessary´ tests. For example, Fowkes et al reported on the use of guidelines produced by the Royal College of Radiologists to reduce unnecessary skull radiographs in patients attending an accident and emergency department following head injuries [82]. The numbers of skull radiographs in new attenders was reduced to approximately one half without any apparent increase in the numbers of patients with head injuries admitted for observation. However, these authors felt that a sustained commitment on the part of the senior medical staff would be necessary if this reduction in the use of tests were to be maintained. Heath recently reported 7 years´ experience of audit on a general medical and clinical pharmacology unit in Birmingham [83]. This continuous audit involved an independent clinical auditor who

reviewed approximately one quarter of hospital in-patient records which were selected in an unsystematic way. As a result of this continuous review of the records the quality of the documentation improved and there was a reduction in the numbers of diagnostic tests that were requested and drugs that were prescribed. This author, however, commented on the difficulty of persuading clinical colleagues in other disciplines at the same hospital to become involved in audit.

Attempts are also being made to improve the quality of primary health care. For example, the Royal College of General Practitioners recently published a report which considered how the quality of primary care might be improved [84].

Despite these examples of attempts to influence professional behaviour through the evaluation of the efficiency and quality of care, it must be concluded that many of these attempts are perceived as being threatening by the professionals [85]. Attempts at evaluation have evolved in a somewhat haphazard fashion with no overall control and coordination and have depended upon a sustained commitment of time and effort from the professionals involved. It is obviously desirable that such investment in the process of evaluation should produce commensurate benefits in terms of improved health outcomes. As yet there is insufficient evidence in the literature to suggest that evaluation changes professional behaviour sufficiently to justify this investment [24].

3.3 EVALUATION, ELDERLY PEOPLE AND TECHNOLOGY.

The problems encountered in attempting to translate the ideology of evaluation into practice are particularly obvious in the context of the evaluation of the health care of elderly people and of technology and surgical treatment.

3.3.1 THE HEALTH CARE OF ELDERLY PEOPLE.

Elderly people are not a homogeneous group. As they approach the end of their life they tend to suffer from increasing, multiple, health problems and disabilities. This has been confirmed in various surveys of self-reported disability and illness [86] [87] [88]. For example, Harris found that the proportion of people reporting `very severe´ or `severe´ impairment increased from about 15 per cent in the age-group 50 to 64 years, to about 24 per cent in the age-group 75 years and older. As elderly people reach the end of their life, prolongation of life may seem less important than the alleviation of suffering. These objectives may conflict with each other and any attempt to reach agreement about the objectives of health care for elderly people should include an assessment of the wishes of the elderly people themselves. It is the `oldest old´ who are most likely to be disabled and for these people it can be difficult to agree the objectives of health care [89]. Care and rehabilitation may seem more important than attempts at cure and may more appropriately be provided by a non-medical health care team [90]. Care has been defined as attending to those needs which affect individual welfare and quality of life [91]. Thus the health care of elderly people must be more than medical care and must include a range of paramedical and social welfare services, both for the

patient and to support the carers in the community. Williams, for example, has recently proposed a model which attempts to describe `social performance´ in elderly people as an aid in the provision of appropriate social support [92]. Such care is a more long term process and is more fragmented between different private and public sectors. This creates problems in attempting to enumerate, quantify and value the resource inputs and health care outcomes.

There is a particular difficulty in attempting to value the health outcomes of caring for elderly people. Economic appraisal of efficiency requires that an attempt be made to place some kind of value on, say, extending an 80 year old life by 1 year or reducing the pain or disability of an elderly person by about 50 per cent. The concept of opportunity cost may require that a comparison be made between these kinds of health outcomes and the outcomes of health care in younger people, for example, extending the life of a 40 year old person by 20 years through renal transplantation. Such comparison involves a process of valuation of these different kinds of health outcomes. Cross-sectional studies of different societies have suggested that, in comparison with traditional, rural, pre-industrial societies, the social status of elderly people in modern socieites is lower and that elderly lives have become devalued in a social sense [93]. However, it is difficult to judge whether in societies which are now modern there has been a decline in the social status of elderly people or whether these societies have always undervalued elderly people. In an economic sense, one way of attempting to value human lives is the human capital approach and this approach, which emphasises the productive capacity of younger lives in employment, also devalues older lives [42]. It is arguable whether such social prejudices should be taken account of in the process of valuation which is an essential, if not always explicit, part of the evaluation of health care [94] [74].

Thus there are particular difficulties in attempting to evaluate the health care of elderly people: because such care is long term and fragmented between different sectors there can be problems of measurement of resource inputs; because elderly people towards the ends of their lives have multiple problems, it can be difficult to agree the objectives of health care; and because elderly lives seem to be devalued socially, it can be difficult to value health outcomes in this age-group in a way which is consistent with ideas of justice.

3.3.2 HEALTH CARE AND TECHNOLOGICAL INNOVATION.

Technological innovation in health care has certainly extended the bounds of the possible and has been a major factor in rising health care costs. From the point of view of the evaluation of health care the problem is to decide what level of provision of technology is appropriate and what should be the objectives of such provision. The evidence suggests that there is no consensus about the answers to these questions. Variations in the rates of provision of various new technologies and surgical treatments in modern industrialised countries cannot easily be explained in terms of differences in the incidence or prevalence of disease. Bunker was one of the first to point out the different rates of operation for selected surgical procedures between the United States of America and England and Wales [95]. His conclusions were:

> "There are twice as many surgeons in proportion to population in the United States as in England and Wales, and they perform twice as many operations. . . Indications for surgery are not sufficiently precise to allow determination of whether American surgeons operate too often or the British too infrequently."

Another example of such variations is provided by the treatment of end-stage renal disease [96]. For example, in 1981, the rate of acceptance for treatment of patients with end-stage renal failure in England was 25.4 new patients per million population compared with over 40 per million in France, West Germany and Italy [97]. Only 8 per cent of British patients were aged over 65 years compared with about 25 per cent in the other 3 countries. Within Britain, there were similar, unexplained variations between different regions.

The debate is partly about the appropriateness of different levels of provision and partly about the effectiveness of new technologies in everday practice [98]. Early studies suggested that even for simple surgical procedures, where the objectives of treatment are apparently very clear, variations in operation rates did not necessarily correlate with outcome measures. For example, Lembcke studied appendicectomy rates in different hospital catchment areas in New York State and tested the hypothesis that if the surgical treatment of acute appendicitis saved lives, there would be an association between high appendicectomy rates and low appendicitis mortality rates [99]. He found no such association and for this reason he questioned the effectiveness of this accepted surgical practice. It takes time to develop expertise in the application of technological innovations, particularly outside centres of excellence. Also most evaluation of new technologies, in addition to taking place in centres of excellence, tends to be on younger, relatively fitter patients. Having shown that a technique such as coronary artery bypass grafting can be effective in alleviating refractory angina in patients with multi-vessel disease, there is a need to show that the same technique as applied in practice is `cost-effective´. Codman asserted as long ago as 1914 that there is a need to consider the `end results´ of surgical interventions in everday practice so as to evaluate the efficiency

of hospital care [100].

Thus there has been a continuing debate about the effectiveness of surgical interventions, particularly in the case of the more recent, costly and spectacular innovations. Some such innovations, such as extra-corporeal shock wave lithotripsy, have been categorised as `slam-bang´ technology since the effectiveness of the procedure is said to be apparent without formal trials [101]. Such judgements can create real difficulties for subsequent attempts at formal evaluation because of ethical resistance, perceived interference in clinical freedom and commercial pressures. Such difficulties recently led to the failure to mount a randomised, controlled trial of lithotripsy although attempts at economic evaluation have not been inhibited by doubts about the effectiveness of this procedure as it will be applied in practice [102] [103]. In the case of other innovations, the results or health outcomes are rather more uncertain. Such uncertainty can persist even after several costly, randomised, controlled trials. For example, Hampton recently reviewed the findings of 3 randomised, controlled trials of coronary artery bypass surgery for the alleviation of coronary artery disease [104]. He concluded that it was not possible to be sure that such surgery improved the survival of patients with angina. Williams has criticised what he believes to be the exaggerated emphasis given to survival in these trials and has argued that a more important consideration is the quality of life-years gained from coronary artery bypass grafting [105]. Williams advocates the use of scales of classification of illness states such as that developed by Rosser and her colleagues to measure quality of life [106]. He does, however, agree that further work is needed before it will become possible to be confident about the outcome of coronary artery bypass grafting in terms of `quality-adjusted life years´.

In recent years there has been considerable discussion about defining, quantifying and eliminating `unnecessary surgery´ and it has been concluded that:

> "the term `unnecessary surgery´ has no value without an adequate definition, and, at present, a suitable one has not been found [19]."

An economic definition of unnecessary surgery as the application of procedures when the expected benefits fall short of the expected costs has been proposed [107]. This definition can be improved by considering the additional or marginal costs of the extra health care inputs and the marginal health benefits [41]. Surgery would be considered to be unnecessary when the expected marginal benefits were less than those obtained from the same health care inputs in their best alternative use. However, although there can be little difficulty in accepting the notion of economic scarcity in the domain of health care, the methodology of economic appraisal is still at a relatively early stage of development. It has been suggested that it is more useful to think in terms of inappropriate rather than unnecessary surgery [19]. This still leaves the fundamental difficulty of agreeing the objectives of and indications for such treatments and technologies. Recent attempts to overcome this problem have included the idea of the `consensus conference´ in which informed representatives of the various vested interests involved meet in an attempt critically to review evidence of effectiveness and appropriate application (see, for example, [108]).

In the absence of convincing evidence to the contrary, it must be concluded that variations in the rate of different technological and surgical procedures must reflect, at least in part, variations

in professional judgement about the objectives, effectiveness and appropriateness of such treatments. The evaluation of health care needs to take account of the objectives of such care. In the absence of consensus about these objectives, evaluation becomes more problematic.

3.4 CONCLUSIONS.

The ideology of evaluation emphasises that decisions about the allocation of health care resources, and about broader policy issues relevant to health, should be made as rational as possible. Evaluation can only be justified if it results in decisions being taken which produce desired change. In practice, however, the more formal types of evaluation involve conceptual difficulties, methodological constraints and real costs, both in time and money, which are not easy to reconcile with the need to make quick decisions in a rapidly changing environment. This is particularly true in the complex domain of health. Policy makers have to live with the real paradox that whereas the more rapid the pace of social change, the more necessary information becomes, this rapid social change of itself tends to undermine the rational use of such information. In addition, because of inbuilt inertia to change and a plurality of vested interests, there can be real problems in implementing even the most rational decisions in the face of economic scarcity [109].

The more formal kinds of evaluation, such as the randomised, controlled, trial are a luxury where resources are scarce and where there is rapid social change and are not a panacea for the problems of decision making in a complex society. For example, while the multiple risk factor intervention trial cited above was in progress

one of the desired objectives, namely a reduction in coronary artery disease mortality in the United States, was occurring for reasons which are largely speculative [110]. It could be argued that the routine mortality data were a more useful resource for evaluating progress against coronary artery disease than the formal trial. Williams has suggested some criteria for determining the appropriateness of the more formal kinds of economic appraisal including: the amount of resource inputs involved, the degree of fragmentation of responsibility, the degree of uncertainty about objectives, the existence of alternative health care interventions, the extent to which the technology is understood, and the speed with which decisions need to be taken [111].

More recently in the British National Health Service, there has been an increasing emphasis on improving routine information as a means of monitoring the implementation of change [112]. This trend is in line with the increasing recognition that since the health service is publicly financed, there is a need for management accountability and central monitoring of performance in achieving stated objectives [113] [114]. Clinicians are slowly accepting the idea that clinical freedom, i.e. the right of the doctor to do whatever he or she considers to be in the best interest of the patient, is `dead´ [115]. The process of evaluation is no longer merely a rational process for resource allocation but is becoming an essential tool for monitoring performance in the modern, managed health service. This is not to suggest that the randomised, controlled, trial should not be used, rather that as Dudley has argued, the whole range of evaluative methodologies should be considered when information is needed. They should be applied with due consideration of the constraints and resource consequences involved, the rapidity with which decisions need to be taken, and the likelihood of implementing change. Some decisions may not

require the most cogent evidence and a less formal, more rapid methodology may be more useful. Clearly, the different evaluative techniques need to be applied intelligently and selectively. Although some attempts have been made to consider evaluative techniques critically (see, for example, [78] [116]), review of the literature would suggest that there is no obvious consensus about priorities for evaluation or about the appropriate use of the different methodologies.

Chapter 4

METHODOLOGY.

4.1 THE PROSPECTIVE COHORT STUDY.

4.1.1 CRITERIA FOR INCLUSION IN THE STUDY.

All cases of proximal femoral fracture in Stockport residents aged 25 years and over during a period of eighteen months from 1.3.84 to 31.8.85 were included in a prospective cohort study. Patients were included if they had been living in Stockport for at least four weeks before the fracture.

The definition of proximal femoral fracture included fractures of the femur proximal to and including the lesser trochanter but excluded sub-trochanteric fractures and isolated fractures of the greater or lesser trochanter. Where the date of the fracture was not known, for example because of spontaneous onset without trauma, or because of the patient's mental confusion, the date of diagnosis of the fracture was used instead of the fracture date as a criterion for inclusion in the study. The fracture cases included individuals experiencing their first proximal femoral fracture, individuals experiencing a fresh femoral fracture, not their first, during the study period and a few individuals who experienced more than one fracture during the study period. Patients who were admitted to hospital during the study period for the treatment of fractures which occurred before the study period were not included and patients who were admitted to hospital more than once during the

study period for the treatment of the same fracture were only included once.

4.1.2 THE ASCERTAINMENT OF CASES.

Most of the cases were ascertained by daily examination of hospital admission records at Stockport Infirmary. The reports of all radiological examinations of the hip and pelvis which were performed in Stockport during the study period were scrutinised. At the time of the study, Stockport was in the metropolitan county of Greater Manchester and it was expected that some Stockport residents with proximal femoral fractures might be treated at hospitals in other health districts in the metropolis.

Figure 1 (page 29) shows the geographical location of those acute hospitals in adjacent health districts providing an acute orthopaedic service which might be expected to admit Stockport residents with acute proximal femoral fractures.

These hospitals include Wythenshawe Hospital, Manchester Royal Infirmary, Ancoats Hospital, Tameside District General Hospital and Macclesfield District General Hospital. Acute orthopaedic admissions were monitored at each of these hospitals on a regular basis throughout the study period, by scrutiny of casualty registers or ward admission books.

All death notifications from the Registrar of Births, Deaths and Marriages to the District Medical Officer in Stockport were scrutinised from 1.3.84 to 31.12.85 to identify any patients in whom the causes of death included a proximal femoral fracture.

The Hospital Activity Analysis computer file was searched for Stockport residents discharged from or dying in any hospital within the region with a diagnosis of femoral neck fracture (ICD 820)

during the period 1.3.84 to 31.12.85.

As a further check on the ascertainment of cases the relative frequency of new fractures occurring between 1.3.84 and 31.8.85 in people aged 65 years and over in the 21 electoral wards within the district was tested using the binomial distribution so as to ensure that there was no systematic non-detection of fractures in those electoral wards on the boundary of the district [117]. This might occur if patients in these electoral wards tended to be treated in hospitals outside Stockport.

Stockport Health Authority provides services for the residents of the High Peak district of North Derbyshire and such people with acute proximal femoral fractures are usually treated at Stockport Infirmary. Those non-Stockport residents who were treated at the Infirmary were included in the survey for part of the analysis as detailed below.

4.1.3 THE ESTIMATION OF ANNUAL INCIDENCE RATES.

The Office of Population, Censuses and Surveys estimate of the Stockport population as at 30 June, 1984, for both sexes and for 5 year age-groups, was used to estimate annual age and sex specific incidence rates for proximal femoral fractures in Stockport. The numerator in the estimate of the annual incidence rate was the total number of fresh fractures occurring in Stockport residents during the study period.

4.1.4 DATA COLLECTION.

The data were collected by the author by personal interview with the patients or their relatives as soon as possible following admission to hospital because of a proximal femoral fracture. Additional information was obtained from the hospital records. The data were stored in a microcomputer file.

Table 3 summarises the information which was obtained about each patient.

TABLE 3.

INFORMATION COLLECTED ON EACH PATIENT.

AGE

SEX

DATE OF FRACTURE

TIME OF FRACTURE

MECHANISM OF FRACTURE

DATE OF ADMISSION

RESIDENCE BEFORE FRACTURE

MOBILITY BEFORE FRACTURE

DEPENDENCE BEFORE FRACTURE

LATEST OCCUPATION

MEDICAL HISTORY

DRUG HISTORY

BLOOD HAEMOGLOBIN, CORRECTED CALCIUM, PHOSPHATE AND ALKALINE PHOSPHATASE

MENTAL TEST INTERVIEW ON ADMISSION

X RAY REPORT

TREATMENT

LENGTH OF STAY - ACUTE BED
REHABILITATION BED
CONTINUING CARE BED

MEDICAL COMPLICATIONS

RESIDENCE
MOBILITY AT SIX MONTHS FOLLOWING FRACTURE
DEPENDENCE

DATE AND CAUSE OF DEATH IF WITHIN 6 MONTHS.

The detailed information which was collected about each patient is indicated on the data collection pro forma (Appendix). The patient's ability to walk before the fracture was assessed using an ordinal scale. The fracture was classified into either

intra-capsular (sub-capital or cervical) or extra-capsular (trochanteric). Sub-capital fractures occurring in Stockport residents in the main study were further classified according to Garden's classification [33]. The mechanism of the fracture was classified according to the type of trauma that was associated with the fracture.

An attempt was made to assess the mental function of the patients as soon as possible after admission to hospital and before any surgical treatment. The patients were asked questions designed to test information, memory and concentration. This test had previously been used by Blessed et al. and, because the patients were newly admitted to an unfamiliar hospital environment, the test was modified by omitting the question about recognition of two people [118]. This test produced an ordinal score for mental function ranging from a minimum score of 0 to a maximum possible score of 35.

Where the results of the test suggested that the patient was confused or disorientated on admission to hospital, further information about the patient was obtained from relatives or close acquaintances.

The ability of the patient to perform activities of daily living before the fracture was assessed at interview using a classification developed and used at the Benjamin Rose Hospital in Cleveland, Ohio, U.S.A. [119]. This classification assigned an ordinal score for dependency ranging from 1 (independent) to 7 (dependent).

4.1.5 THE ASSESSMENT OF THE OUTCOME OF TREATMENT.

An attempt was made to visit all patients who were still alive 6 months (182 days) following their fracture and who were still living in Stockport. If the patient had moved out of the district an attempt was made to obtain information by telephone interview with the patient or relatives.

4.1.6 THE RELATIONSHIP BETWEEN SELECTED CHARACTERISTICS OF THE PATIENTS BEFORE OR AT THE TIME OF THE FRACTURE AND OUTCOME.

In order to obtain the maximum number of cases, in addition to those Stockport residents sustaining a proximal femoral fracture during the main study period, all other patients, non-resident in Stockport, who were admitted to Stockport Infirmary during the same period with an acute proximal femoral fracture were included for this part of the analysis. Whether or not the patient lived in Stockport was included in the analysis as an independent variable. All the patients in the study were assessed at 6 months (182 days) following their proximal femoral fracture.

4.1.6.1 INDEPENDENT VARIABLES.

Table 4 summarises those independent variables which were examined for their relationship with outcome at 182 days. These variables were measured on nominal (for example, residence before the fracture), ordinal (for example, dependency score before the fracture) or ratio (for example, blood haemoglobin concentration) scales of measurement. The variables could be either continuous (for example, blood haemoglobin concentration) or discontinuous (for example, the month in which the fracture occurred) and some of the discontinuous variables measured on a nominal scale of measurement

(for example, sex) were dichotomous.

TABLE 4.

INDEPENDENT VARIABLES.

VARIABLE.	TYPE.	SCALE.
SEX	DICH	NOMINAL
FRACTURE TYPE	DICH	NOMINAL
MONTH IN WHICH FRACTURE OCCURRED	DIS	NOMINAL
INTERVAL BETWEEN FRACTURE AND ADMISSION	DIS	RATIO
AGE AT THE TIME OF FRACTURE	DIS	RATIO
WHETHER LIVING ALONE BEFORE FRACTURE	DICH	NOMINAL
WHETHER RETIRED BEFORE FRACTURE	DICH	NOMINAL
WHETHER DRIVING A CAR BEFORE THE FRACTURE	DICH	NOMINAL
HISTORY OF PREVIOUS PROXIMAL FEMORAL FRACTURE	DICH	NOMINAL
WHETHER ABLE TO CLIMB 1 FLIGHT OF STAIRS UNAIDED	DICH	NOMINAL
WHETHER ABLE TO RISE FROM A CHAIR BEFORE FRACTURE	DICH	NOMINAL
WALKING ABILITY BEFORE THE FRACTURE	DIS	ORDINAL
USUAL RESIDENCE BEFORE THE FRACTURE	DIS	NOMINAL
WHETHER AN ACTIVE MEDICAL PROBLEM AT TIME OF FRACTURE	DICH	NOMINAL
WHETHER ON REGULAR DRUG TREATMENT AT TIME OF FRACTURE	DICH	NOMINAL
DEPENDENCY SCORE BEFORE THE FRACTURE	DIS	ORDINAL
BLOOD HAEMOGLOBIN LEVEL	CON	RATIO
BLOOD PHOSPHATE LEVEL	CON	RATIO
BLOOD ALKALINE PHOSPHATASE LEVEL	CON	RATIO
BLOOD ALBUMIN LEVEL	CON	RATIO
BLOOD CALCIUM LEVEL	CON	RATIO
MECHANISM OF THE FRACTURE	DIS	NOMINAL
INTERVAL BETWEEN ADMISSION AND PRIMARY TREATMENT	DIS	RATIO
PRIMARY TREATMENT	DIS	NOMINAL
MENTAL TEST SCORE	DIS	ORDINAL
WHETHER PRIMARY TREATMENT IN STOCKPORT	DICH	NOMINAL
WHETHER RESIDENT IN STOCKPORT	DICH	NOMINAL

DICH = DICHOTOMOUS.
DIS = DISCONTINUOUS.
CON = CONTINUOUS.

4.1.6.2 OUTCOME.

Two outcome variables were used in the analysis: survival limited to 6 months following the fracture, and ability to walk at 6 months following the fracture. These variables can be considered to be indices of mortality and morbidity respectively. The ability to walk was assessed using an ordinal scale ranging from 1 (walking unaided) to 7 (confined to bed). The ordinal scores before and 6 months following the fracture were compared and the independent variable (walk outcome) could take 1 of 2 values: 1 (walking ability at 6 months same as or better than walking ability before the fracture - `success´), and 0 (walking ability at 6 months worse than before the fracture - `failure´).

SURVIVAL.

Survival times to 6 months (`singly censored´) were calculated in days. The relationship between the independent variables and survival (dependent variable) was examined using both univariate and multivariate techniques to identify prognostic factors [120].

Univariate analysis.

For those variables which were dichotomous (for example, sex) or measured on a continuous interval or ratio scale (for example, blood haemoglobin concentration), the individual effect of each variable was examined using the Cox-Mantel test [121]. The continuous variables were transformed into dichotomous variables by splitting the observations for each variable approximately at the median value. For example, in the case of the blood haemoglobin concentration the observations were classified into 2 groups split at the median value: less than 12 g/dl, and greater than or equal to 12 g/dl. The month of the fracture was treated as a dichotomous

variable by re-classifying the 12 months into 2 periods: Winter (October to March), and Summer (April to September). The mental test score, a discontinuous variable measured on an ordinal scale, was also transformed into a dichotomous variable by splitting at the median and was examined using the Cox-Mantel test.

For the remaining, grouped variables, which were discontinuous and measured on either a nominal (for example, primary treatment) or an ordinal (for example, dependency score) scale, the individual effect of each variable was examined using the Kruskal-Wallis test for k groups [122].

Cases with missing values for any particular variable were excluded from the univariate analysis for that variable.

Multivariate analysis.

The joint effects of the independent variables on survival were analysed using Cox's proportional hazard regression model [120]. A computer programme (BMDP programme P2L) was used for the analysis [123]. In the preliminary analysis all the variables were entered into the model using a forward stepwise procedure. The order of insertion of the variables into the model was determined by using the maximum log-likelihood value as a measure of the importance of variables not yet in the equation.

Having determined which independent variables appeared to have a significant association with survival, a further analysis was made using a restricted number of covariates which appeared to be important. The regression was initially computed using all these covariates in the model. The variables were then removed according to their importance as judged by the maximum log-likelihood value. The least important variables were removed consecutively using a backward elimination or stepdown procedure until a satisfactory

regression was obtained.

Cases with missing values for any of the restricted number of covariates were excluded from the analysis.

The significant variables which remained in the regression were used arbitrarily to classify the cases into 2 groups with good and bad predicted survival limited to 6 months.

ABILITY TO WALK 6 MONTHS FOLLOWING THE FRACTURE.

The subjects were classified into 2 groups, `success´ and `failure´, on the basis of their walking ability at 6 months following the fracture as described in section 4.1.6.2 above. Cox´s linear logistic regression method was used to examine the joint effects of the independent variables on the probability of a successful outcome [124]. A computer programme (BMDP programme PLR) was used in the analysis [125].

In the preliminary analysis, all the covariates were used in the model and were entered into the regression using a forward stepwise procedure. At each step, the set of coefficients, **b**1, ...,**b**p for the p included variables, **x**1, ...,**x**p were estimated as the value that maximised the likelihood function. The decision to enter variables was based upon an approximate F value which was computed from an estimate of the asymptotic covariance matrix of **b**. The tail area probability was computed from the F value and a variable was entered if its p-value was less than or equal to 0.15. The variable with the smallest p-value was entered at each step. Having entered all the variables which were significant at P <= 0.15, a backward stepwise procedure was then used to remove variables with a p-value of greater than 0.05.

Following this preliminary analysis, a restricted number of

covariates, including the significant variables, was used in the model in a further analysis until a satisfactory regression was obtained. In this further analysis, the decision to enter or remove terms was based upon the logarithm of the ratio of the maximised likelihood functions at each step.

Cases with missing values for any of the restricted number of covariates were excluded from the further analysis.

4.1.7 COMPARISON WITH THE GENERAL SURVIVAL EXPERIENCE OF ELDERLY PEOPLE IN STOCKPORT.

A life table method was used to estimate the cumulative percentage survival up to 6 months of the general Stockport population aged 65 years and over [120]. The Registrar's notifications of deaths to the District Medical Officer were scrutinised for a 6 month period from 30 June, 1984. The numbers of deaths for each of the 26 weeks was calculated for both sexes and for 5 year age-groups from aged 65 years upwards. The Office of Population, Censuses and Surveys estimated mid year population for Stockport as at 30 June, 1984 was used as an estimate of the numbers alive in each age-group for both sexes at the start of the 6 month period. The estimated cumulative survival of the proximal femoral fracture patients aged 65 years and over in the prospective cohort study was calculated in a similar manner.

4.1.8 ETHICAL ISSUES.

Following a full explanation of the purpose of the study verbal consent to participation was obtained from all the patients or their relatives. The study was approved by the Stockport ethical committee. No personal identification details were stored on the computer. The author was included as a data user under the Data

Protection Act in the registration of the North Western RHA.

4.2 THE ASSESSMENT OF RECENT TRENDS IN THE EFFICIENCY OF HOSPITAL CARE FOR PROXIMAL FEMORAL FRACTURES IN ENGLAND AND WALES.

Mortality statistics for fractured neck of femur (International Classification of Diseases code 820) and mid year population estimates for England and Wales were used to calculate mortality rates for both sexes and for five age-groups: 65 to 69, 70 to 74, 75 to 79, 80 to 84, and 85 years plus for the years 1964 to 1983 [126]. These rates were then applied to the estimated mid year population of England and Wales for 1974 in the age-groups over sixty-five years for both sexes to calculate standardised mortality rates (direct method) for fractured neck of femur in people aged 65 years and older. The year 1974 was chosen as a standard since it is approximately the middle of the period. This standardisation allows for changes in the age structure of the elderly population between 1968 and 1983. Hospital In-patient Enquiry statistics for femoral neck fractures for England and Wales for the years 1968 to 81 for both sexes were used to calculate hospital fatality ratios (expressed as a percentage) and mean durations of hospital stay for two age-groups: 65 to 74, and 75 years plus [127]. HIPE tables for 1982 onwards relate only to England and were not used. The fatality ratio is the ratio of the numbers of deaths in hospital during a defined period to the total numbers of discharges and deaths during the same period. Temporal trends in hospital fatality ratios and in mean durations of hospital stay were examined using a simple linear regression model ($y = a + bx$). `Student´ ´s t test was used to test the significance of the difference between the estimated regression coefficient, b, and zero [128].

4.3 THE ASSESSMENT OF THE ACCURACY OF THE HOSPITAL ACTIVITY ANALYSIS STATISTICS IN STOCKPORT.

These statistics are held on a computer file by the North Western Regional Health Authority. Information is collected for hospital in-patients at the time of discharge from or death in hospital and includes age, sex, OPCS residence code, hospital case number, diagnosis and dates of admission and discharge or death. An ad hoc search of the computer file was made for patients discharged from or dying in hospital between 1 March, 1984 and 31 December, 1985, aged 25 years and older, resident in Stockport and with a diagnosis of femoral neck fracture, ICD 820. The hospital case notes of any such patients who had not been included in the prospective cohort study were reviewed.

Chapter 5

RESULTS.

5.1 THE PROSPECTIVE COHORT STUDY.

This study included 396 fracture cases occurring between 1 March, 1984 and 31 August, 1985.

The pilot study included 104 fractures which were identified during the 6 month period between 1 March, 1984 and 31 August, 1984. The main study included 292 fractures occurring between 1 September, 1984 and 31 August, 1985, of which 237 were in Stockport residents. The total number of fractures included in both the pilot and main studies in Stockport residents over the 18 month period between 1 March, 1984 and 31 August, 1985 was 325. Since 3 individuals had 2 proximal femoral fractures over the 18 month period and 1 individual had 3, the total number of Stockport residents included in the study over the 18 month period was 320. Of the 325 fractures occurring in Stockport residents over 18 months, 301 were the first proximal femoral fracture experienced by the individual.

Table 5 shows the number of cases broken down by month of occurrence, place of treatment and place of residence.

TABLE 5.

CROSS-BOUNDARY FLOWS FOR THE TREATMENT OF PROXIMAL FEMORAL FRACTURES IN STOCKPORT - 1 MARCH, 1984 TO 31 AUGUST, 1985.

MONTH.	a.	b.	c.	d.	a + c + d.	a + b.
MAR 84	23	3	5		28	26
APR 84	14	1	2		16	15
MAY 84	10	1	1		11	11
JUN 84	11	1	4		15	12
JUL 84	11	0	0		11	11
AUG 84	11	2	4		15	13
PILOT	80	8	16		96	88
SEP 84	18	3	6		24	21
OCT 84	14	2	2		16	16
NOV 84	18	3	2		20	21
DEC 84	17	3	4		21	20
JAN 85	26	4	6		32	30
FEB 85	17	2	2		19	19
MAR 85	13	1	4		17	14
APR 85	19	2	8	1	28	21
MAY 85	13	5	4		17	18
JUN 85	19	5	3		22	24
JUL 85	14	2	10		24	16
AUG 85	17	0	3		20	17
MAIN	205	32	54	1	260	237
MAIN + PILOT	285	40	70	1	356	325

a. = Stockport residents receiving primary treatment in Stockport.

b. = Stockport residents receiving primary treatment elsewhere.

c. = Non-Stockport residents receiving primary treatment in Stockport.

d. = Non-Stockport residents receiving primary treatment outside Stockport, but transferred to Stockport for rehabilitation.

5.1.1 THE ANNUAL INCIDENCE RATE FOR PROXIMAL FEMORAL FRACTURES IN STOCKPORT.

Table 6 shows the estimated annual incidence rate, broken down by age (5 year age-groups) and sex, together with the standard errors, for proximal femoral fractures in Stockport.

Figure 2 illustrates graphically how the annual incidence rate changes with age and sex.

In Figure 3 the logarithm of the annual incidence rate is plotted against age for both sexes. It can be seen that there is an approximately exponential increase in incidence with age from about the 6th decade of life onwards in both males and females.

TABLE 6.

AGE/SEX SPECIFIC INCIDENCE RATE OF FEMORAL NECK FRACTURES IN STOCKPORT [POPULATION 289,100] BETWEEN 1 MARCH, 1984 AND 31 AUGUST, 1985.

AGE-GROUP (YEARS)	NOS. OF FRACTURES IN 18/12	1984 MID YEAR POPN. ESTIMATE THOUSANDS	ANNUAL INCIDENCE RATE PER 100,000	STANDARD ERROR OF INCIDENCE RATE
		MALES.		
25-	0	9.9	0	
30-	0	10.0	0	
35-	3	10.9	18.33	10.6
40-	1	9.0	7.40	7.4
45-	0	8.5	0	
50-	0	8.2	0	
55-	5	8.0	41.63	18.6
60-	4	7.8	34.16	17.1
65-	5	5.2	64.04	28.7
70-	12	4.8	166.51	48.1
75-	10	3.2	208.14	65.8
80-	10	1.6	416.29	131.3
85+	10	0.7	951.51	299.0
TOTAL	60			
		FEMALES.		
25-	1	9.8	6.80	6.8
30-	1	9.9	6.73	6.7
35-	0	11.2	0	
40-	0	9.0	0	
45-	1	8.7	7.66	7.7
50-	1	8.3	8.02	8.0
55-	3	8.2	24.37	14.1
60-	12	8.7	91.87	26.5
65-	12	6.6	121.10	35.0
70-	31	7.0	294.97	52.9
75-	65	5.8	746.44	92.1
80-	58	3.8	1016.62	132.6
85+	80	2.5	2131.39	234.7
	265			
		BOTH SEXES.		
25-	1	19.7	3.38	3.4
30-	1	19.9	3.35	3.4
35-	3	22.1	9.04	5.2
40-	1	18.3	3.64	3.6
45-	1	17.2	3.87	3.9
50-	1	16.5	4.04	4.0
55-	8	16.2	32.89	11.6
60-	16	16.5	64.59	16.2
65-	17	11.8	95.96	23.3
70-	43	11.8	242.72	37.0
75-	75	9.0	555.05	63.9
80-	68	5.4	838.74	101.2
85+	90	3.2	1873.29	194.8
	325			

FIG 2

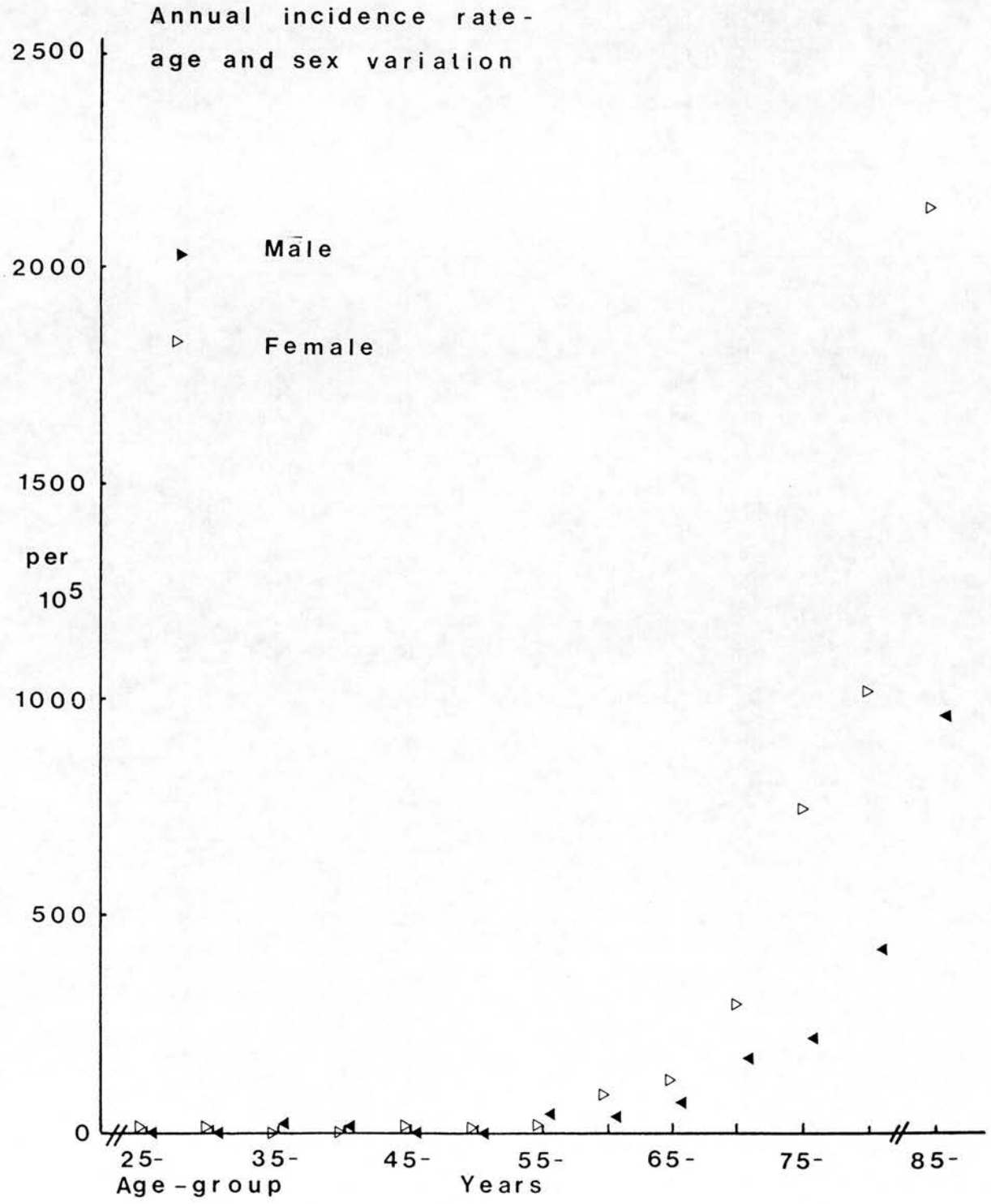

Annual incidence rate-
age and sex variation
2500
2000
1500
per
10^5
1000
500
0
Male
Female
25-
35-
45-
55-
65-
75-
85-
Age-group
Years

FIG 3

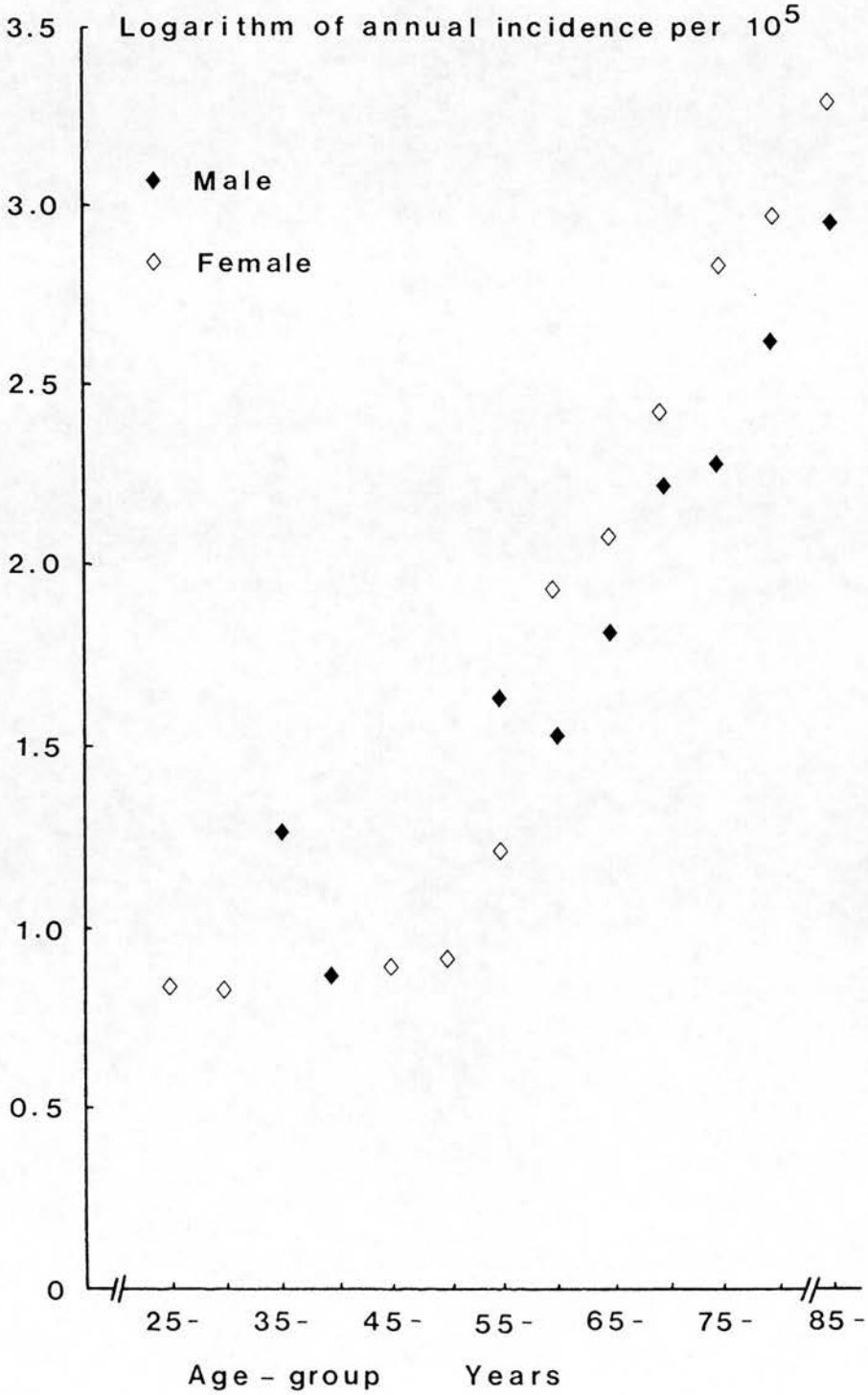

Logarithm of annual incidence per 10^5
Male
Female
3.5
3.0
2.5
2.0
1.5
1.0
0.5
0
25-
35-
45-
55-
65-
75-
85-
Age - group
Years

Table 7 shows the distribution of fracture cases in people aged 65 years and over between the 21 electoral wards in the metropolitan borough of Stockport together with the populations aged 65 years and over in those wards. The number of fractures in each ward (xi variable) was transformed as shown in the table and the ward frequencies were compared on the basis of chi-squared. The value for chi-squared was 18.9 with 20 degrees of freedom. This is not statistically significant ($0.5 < P < 0.6$) and there was, therefore, no evidence of significant under-representation of fracture cases in the wards on the boundary of the district.

TABLE 7.

DISTRIBUTION OF PROXIMAL FEMORAL FRACTURE CASES IN STOCKPORT BY ELECTORAL WARD.

ELECTORAL WARD	NO OF #s AET 65+ YRS IN 18 MONTHS xi	POPULATION AGED 65+ YEARS Ni	xi/Ni	ci	ci^2
BRINNINGTON	9	1815	.0050	-.9013	.8124
MANOR	8	1940	.0041	-1.4717	2.1660
GREAT MOOR	18	2370	.0076	.2328	.0542
DAVENPORT	25	2065	.0121	2.3066	5.3204
CALE GREEN	15	1850	.0081	.4554	.2074
EDGELEY	18	2175	.0083	.5809	.3374
HEATON MERSEY	18	1900	.0095	1.0997	1.2093
HEATON MOOR	18	1860	.0097	1.1782	1.3882
NORTH REDDISH	11	2185	.0050	-.9997	.9994

TABLE 7 - CONTINUED.

ELECTORAL WARD	NO OF #s AET 65+ YRS IN 18 MONTHS xi	POPULATION AGED 65+ YEARS Ni	xi/Ni	ci	ci^2
ROMILEY	11	2185	.0050	-.9997	.9994
BREDBURY	13	2170	.0060	-.4156	.1728
HEALD GREEN	13	1510	.0086	.6250	.3906
CHEADLE AND GATLEY	16	2145	.0075	.1486	.0221
CHEADLE HULME SOUTH	15	1455	.0103	1.2839	1.6484
CHEADLE HULME NORTH	16	2125	.0075	.1854	.0344
HAZEL GROVE	11	1890	.0058	-.4440	.1971
EAST BRAMHALL	15	1585	.0095	.9999	.9999
WEST BRAMHALL	10	1875	.0053	-.7104	.5047
NORTH MARPLE	9	1510	.0060	-.2650	.0702
SOUTH MARPLE	12	1755	.0068	.1088	.0118
SOUTH REDDISH	12	2430	.0049	-1.1495	1.3214
	293	40795	.0072		
	1 - 293/40795 =		.9928		

CHI-SQUARED = 18.8676

d.o.f. = 20

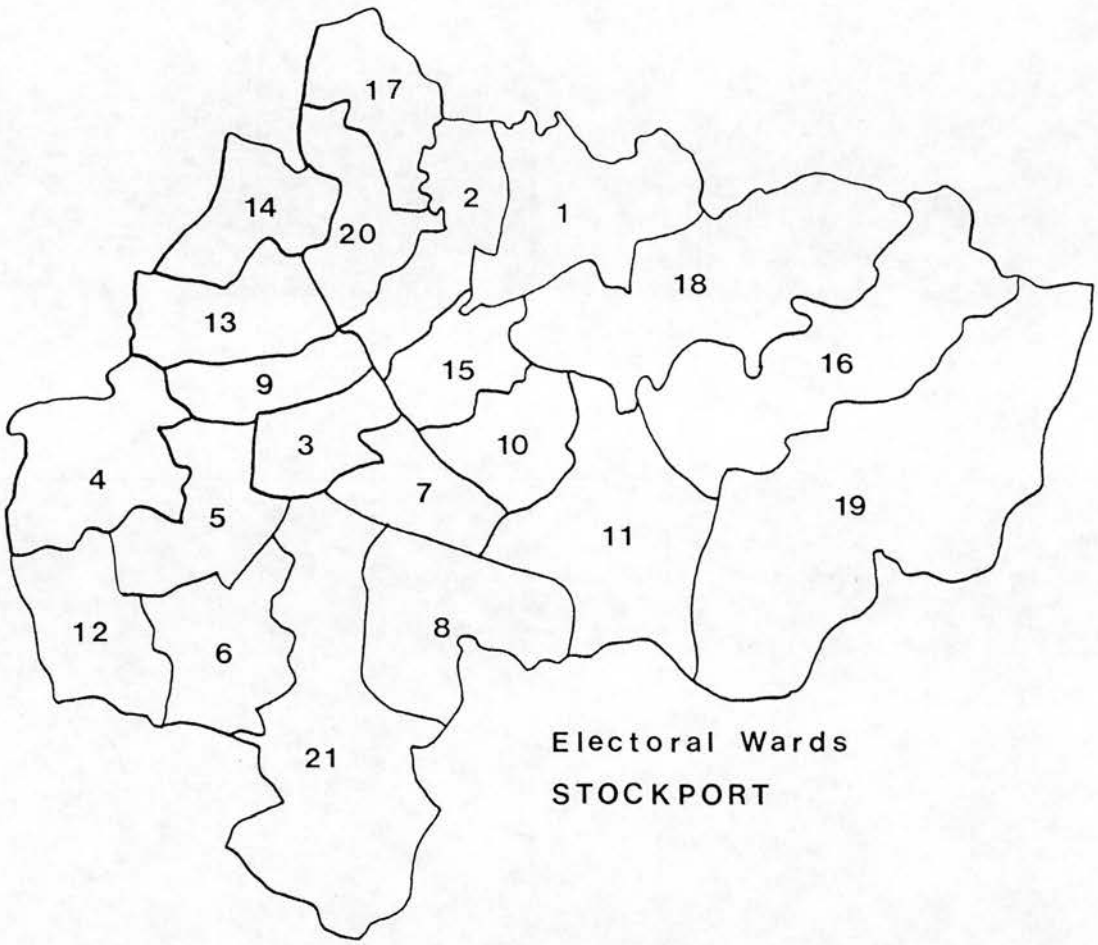
$0.5 < P < 0.6$

Where $ci = 2(\sqrt{(xi+1)0.9928} - \sqrt{(Ni - xi)0.0072})$ when $pi < 0.0072$

and $ci = 2(\sqrt{0.9928xi} - \sqrt{(Ni-xi+1)0.0072})$ when $pi > 0.0072$.

Figure 4 shows the geographical distribution of the electoral wards within the borough.

FIG 4



1 Bredbury
2 Brinnington
3 Cale Green
4 Cheadle
5 Cheadle Hulme N
6 Cheadle Hulme S
7 Davenport
8 East Bramhall
9 Edgeley
10 Great Moor
11 Hazel Grove
12 Heald Green
13 Heaton Mersey
14 Heaton Moor
15 Manor
16 N Marple
17 N Reddish
18 Romiley
19 S Marple
20 S Reddish
21 West Bramhall

5.1.2 1 YEAR COHORT OF PROXIMAL FEMORAL FRACTURES IN STOCKPORT RESIDENTS.

5.1.2.1 AGE AND SEX DISTRIBUTION.

Table 8 shows the age and sex distribution of the 237 fracture cases.

The median age at the time of the fracture was 74.5 years for men and 80 years for women. The female to male ratio was 5.2:1. This preponderance of fracture cases in women has been noted in other studies (see, for example, [2]) and is due to 2 factors: the higher age-specific incidence in older women and the greater numbers of women in the older age-groups.

TABLE 8.

AGE AND SEX DISTRIBUTION OF PROXIMAL FEMORAL FRACTURE CASES IN STOCKPORT.

AGE-GROUP (YRS)	MALES	FEMALES	
25-	0	0	
30-	0	0	
35-	2	0	
40-	1	0	
45-	0	1	
50-	0	1	
55-	3	3	
60-	4	10	
65-	4	10	
70-	5	25	
75-	7	44	
80-	4	46	
85-	4	46	
90-	2	12	
95-	2	1	
	38	199	BOTH SEXES
MEAN AGE (YEARS)	72.1	79.1	78
MEDIAN AGE (YEARS)	74.5	80	79

5.1.2.2 TYPE OF FRACTURE.

Table 9 shows the classification of fractures into sub-capital, cervical and trochanteric. The sub-capital fractures are further classified according to Garden's staging [33]. One hundred and forty-three of the 237 patients (60%) had intra-capsular fractures.

Of the 237 fracture cases, 215 (91%) were in people experiencing their first proximal femoral fracture, 6 were in people who had had a previous proximal femoral fracture on the same side, and 16 were in people who had had a previous fracture on the opposite side.

TABLE 9.

CLASSIFICATION OF PROXIMAL FEMORAL FRACTURES INTO ANATOMICAL TYPE.

N=237

# TYPE	R SIDE	L SIDE
GARDEN I	3	4
GARDEN II	12	14
GARDEN III	17	23
GARDEN IV	25	25
TROCHANTERIC	46	48
CERVICAL	7	3

INTRA-CAPSULAR NOT CLASSIFIED = 10

5.1.2.3 TIME OF FRACTURE.

Table 10 shows the distribution of the times of the injury that was associated with the fracture. The modal time was 10 am and 65 per cent of fractures (132/204) occurred between 7 am and 6 pm. There was a secondary peak at between 9 and 11 pm. Eleven per cent of fractures (23/204) occurred between midnight and 7 am.

TABLE 10.

DISTRIBUTION OF PROXIMAL FEMORAL FRACTURES BY TIME OF OCCURRENCE DURING THE DAY.

N=237

# TIME HOURS (24 HR CLOCK)	NUMBER OF PATIENTS
12MN-	1
01.00-	1
02.00-	5
03.00-	6
04.00-	4
05.00-	3
06.00-	3
07.00-	6
08.00-	6
09.00-	11
10.00-	22
11.00-	16
12MD-	18
13.00-	11
14.00-	10
15.00-	11
16.00-	10
17.00-	11
18.00-	8
19.00-	6
20.00-	7
21.00-	11
22.00-	11
23.00-	5

NOT KNOWN = 34.

Table 11 shows that fractures which followed falls in a public place were much more likely to occur during hours of normal activity (08.00 to 22.00 hours) than other fractures. Thirty-nine out of 146 (26.7%) of these other fractures occurred between 22.00 and 08.00 hours. Of these, 12 were known to have happened either using a commode or en route to the toilet.

Table 11.

THE RELATIONSHIP BETWEEN THE TIME OF THE FRACTURE AND THE PLACE OF INJURY.

		FALL IN PUBLIC PLACE	OTHER	TOTAL
TIME OF FRACTURE	22.00 - 08.00	3	39	42
	08.00 - 22.00	46	107	153
	NOT KNOWN	2	23	25
	TOTAL	51	169	220

Chi-squared = 8.03

d.o.f. = 1

$0.001 < P < 0.005$

5.1.2.4 MECHANISM OF FRACTURE.

Table 12 shows the types of injury which were associated with proximal femoral fractures. Most fractures (94%) followed falls.

Twenty-two per cent (51/233) followed falls in a public place and 24 per cent (57/233) followed falls either in hospital or in residential institutions.

TABLE 12.

THE MECHANISM OF THE PROXIMAL FEMORAL FRACTURE.

N=237.

FRACTURE MECHANISM	NUMBER
SPONTANEOUS, PATHOLOGY	5
SPONTANEOUS, NO PATHOLOGY	5
FALL - PRIVATE HOME/GARDEN	112
FALL - PUBLIC PLACE	51
FALL - RESIDENTIAL INSTITUTION	31
ROAD ACCIDENT - PEDESTRIAN	3
FALL IN HOSPITAL	26
NOT KNOWN	4

Table 13 summarises the actions most commonly associated with those falls (179/237) where a clear history could be obtained. This table provides an indication of some of the commoner hazards facing elderly people. At least 9.7 per cent (23/237) of all fracture cases occurred while going to the toilet.

TABLE 13.

ACTIONS DURING WHICH THE PROXIMAL FEMORAL FRACTURE OCCURRED.

ACTIVITY.	NUMBER OF FRACTURE CASES.
Tripping over steps, stairs	15
Loss of balance getting into and out of bed	14
Leg gave way spontaneously	11
En route to the toilet	12
Using commode	11
Loss of balance rising from chair	10
Slipped on ice while walking outdoors	8
Loss of balance while dressing/undressing	8
Fall while gardening	7
Tripped over rug or carpet	6
Tripped over an electrical cable	5
Tripped over uneven flag/paving stones	5
Slipping on a wet floor or pavement	5
Collision with another elderly person	3
Pedestrian knocked down by motor vehicle	3
Other	56

5.1.2.5 INTERVAL BETWEEN THE FRACTURE AND ADMISSION TO HOSPITAL.

Table 14 shows the distribution of the interval between the fracture and admission to hospital. In 10 patients the date of the fracture was not known either because the patient was confused or because the fracture was spontaneous. Most of the fracture cases (157/227 or 69%) were admitted to hospital on the same day as the

fracture. In a few patients the admission to hospital was delayed because of delays in diagnosis.

TABLE 14.

THE INTERVAL BETWEEN THE PROXIMAL FEMORAL FRACTURE AND ADMISSION TO HOSPITAL IN DAYS.

N=237

INTERVAL	NUMBER OF PATIENTS.
# DATE NOT KNOWN	10
SAME DAY (DAY 0)	157
FOLLOWING DAY (DAY 1)	43
DAY 2	5
DAY 3	4
DAY 4	5
DAY 5	3
DAY 6	1
DAY7	1
DAY 8	2
DAY 10	1
DAY 11	2
DAY 13	2
DAY 32	1

MEDIAN = DAY 0

5.1.2.6 PERSONAL CHARACTERISTICS OF THE PATIENTS BEFORE THE FRACTURE.

Ninety-six per cent of fracture cases were in retired people, 41 per cent in people who lived alone, 74 per cent in people who had an active medical problem before the fracture and 74 per cent in people who were on regular drug treatment.

Table 15 summarises the active medical problems (i.e. problems which either were causing disability or which required continuous treatment at the time of the fracture) experienced by the 237 fracture cases. One hundred and seventy-five patients (74%) were experiencing 276 active medical problems at the time of the fracture.

TABLE 15.

ACTIVE MEDICAL PROBLEMS AT THE TIME OF THE FRACTURE.

MEDICAL PROBLEM.	NUMBER OF CASES.
Dementia	31
Ischaemic heart disease	29
Arthritis	27
Cerebrovascular disease	27
Visual impairment	21
Malignant neoplasms	18
Chronic airways obstruction	18
Hypertension	16
Diabetes mellitus	12
Parkinsonism	12
Depression/neurosis/schizophrenia	12
Anaemia	9
Hypothyroidism	9
Balance problems	7
Epilepsy	7
Peripheral vascular disease	3
Colitis/diverticulitis	3
Peptic ulceration	3
Hyperthyroidism	2
Paget's disease	2
Other	8

Table 16 shows the distribution of mental test scores following admission to hospital. The median score was 25 out of a maximum possible score of 35 and the inter-quartile range was 13 - 31. Eleven per cent (24/227) of fractures were in patients who were

unable to answer any of the 35 questions.

Table 17 shows the distribution of the score for walking ability before the fracture. Fifty-seven per cent of fracture cases were in people who could walk without assistance or walking aids before the fracture and 28 per cent were in people who walked with the aid of 1 stick.

Table 18 shows the distribution of the dependency scores (Activities of Daily Living) before the fracture. Only 37 per cent of the fracture cases were in people who were fully independent (i.e. they were continent of urine and faeces and were independent in feeding, transferring, toileting, dressing and bathing).

Thirty-one per cent of the fracture cases were in people who were unable to climb a flight of stairs without assistance and 6 per cent in people who needed help to get out of a chair. Only 7 per cent of fracture cases were in people who were car drivers before the fracture.

TABLE 16.

DISTRIBUTION OF THE MENTAL TEST SCORES OF PROXIMAL FEMORAL FRACTURE PATIENTS ON ADMISSION TO HOSPITAL - see page 206.

N = 237.

SCORE.	FREQUENCY.
NOT KNOWN	10
0	24
1	3
2	3
3	2
5	2
6	4
8	3
9	2
10	2
11	6
12	3
13	4
14	2
15	3
16	2
17	5
18	6
19	5
20	6
21	6
22	7
23	4
24	4
25	6
26	8
27	9
28	6
29	10
30	13
31	12
32	12
33	14
34	18
35	11
	237

MEDIAN SCORE = 25
INTERQUARTILE RANGE = 13-31.

TABLE 17.

THE WALKING ABILITY OF THE PATIENTS IMMEDIATELY BEFORE THE PROXIMAL FEMORAL FRACTURE - see page 204.

N=237.

WALKING ABILITY BEFORE FRACTURE.	NUMBER.
ABLE TO WALK UNAIDED	128
WALKING WITH 1 STICK	63
WALKING WITH 2 STICKS	4
WALKING WITH FRAME	19
WALKING WITH HELP OF 1 PERSON	4
WALKING WITH HELP OF 2 PEOPLE	3
CHAIRBOUND	5
BEDBOUND	0
NOT KNOWN	11

56.6% OF FRACTURE CASES WERE IN PEOPLE WHO COULD WALK UNAIDED BEFORE FRACTURE

27.9% OF FRACTURE CASES WERE IN PEOPLE WHO WALKED WITH THE AID OF 1 STICK BEFORE FRACTURE

TABLE 18.

DEPENDENCY SCORES OF THE PATIENTS IMMEDIATELY BEFORE THE PROXIMAL FEMORAL FRACTURE - see page 205.

N=237

DEPENDENCY SCORE BEFORE FRACTURE	NUMBER	PERCENT
1	85	37.4
2	65	28.6
3	29	12.8
4	22	9.7
5	7	3.1
6	16	7.0
7	3	1.3
NOT KNOWN	10	

Table 19 shows the place of residence of the patients before the fracture. Sixty-six per cent of cases were in people who lived in their own private household and 15 per cent in residents of nursing or residential homes.

TABLE 19.

PLACE OF RESIDENCE OF PROXIMAL FEMORAL FRACTURE PATIENTS BEFORE THE FRACTURE.

N=237.

RESIDENCE BEFORE FRACTURE.	NUMBER	PERCENT
OWN PRIVATE HOUSEHOLD	155	65.7
WITH RELATIVES	25	10.6
NURSING HOME/RESIDENTIAL HOME	35	14.8
HOSPITAL BED	21	8.9
NOT KNOWN	1	

Of 183 fracture cases in people who were not living in a hospital or residential institution, 19 per cent (33/173 - 7 not known) were regularly being visited by the district nurse. Of 155 fracture cases in people who were not living in the household of relatives or in an institution, 34 per cent (52/152 - 3 not known) received home help services from the local authority.

Table 20 summarises the results of biochemical tests which were performed after the patients had been admitted to hospital.

TABLE 20.

RESULTS OF BIOCHEMICAL BLOOD INVESTIGATIONS ON PATIENTS WITH PROXIMAL FEMORAL FRACTURE AT THE TIME OF ADMISSION TO HOSPITAL.

N = 237.

BIOCHEMICAL TEST.	NUMBER MISSING.	MEAN.	S.D.	MEDIAN.	INTER-QUARTILE RANGE.
HAEMOGLOBIN	2	12.2	1.9	12.3	11.2-13.6
CORRECTED CALCIUM.	19	2.34	0.13	2.33	2.27-2.39
PHOSPHATE	19	0.99	0.26	0.95	0.82-1.1
ALKALINE PHOSPHATASE.	18	145.5	257.2	103.0	84.5-129
ALBUMIN.	18	35.3	3.97	35.0	33-38

5.1.2.7 DURATION OF HOSPITAL STAY LIMITED TO 6 MONTHS FOLLOWING A PROXIMAL FEMORAL FRACTURE.

Table 21 summarises the distribution of durations of hospital stay in acute, rehabilitation and continuing care beds following admission for treatment of an acute proximal femoral fracture. The 237 patients occupied, within the first 6 months following their fracture, a total of 12,291 hospital bed days. The mean duration of hospital stay was 51.9 days. On average, each patient occupied an acute bed for 31 days, a rehabilitation bed for 15 days and a continuing care bed for 5 days. However, 22 patients (9%) were still in hospital 6 months (182 days) following the proximal femoral fracture and the median duration of total hospital stay was 30 days. The rehabilitation beds at Cherry Tree Hospital were only available to female patients of whom 28 per cent (55/199) were admitted to these beds.

TABLE 21.

DURATION OF HOSPITAL STAY FOR PATIENTS WITH PROXIMAL FEMORAL FRACTURE.

N = 237.

DURATION OF STAY (DAYS)	NUMBER	DURATION OF STAY (DAYS)	NUMBER
0	1	47	3
1	4	48	3
2	1	49	3
3	1	50	1
4	4	53	1
5	3	54	2
6	4	56	2
7	2	57	1
8	4	58	3
9	4	59	1
10	4	60	1
11	5	61	1
12	2	62	3
13	3	64	1
14	11	65	1
15	10	66	1
16	4	68	1
17	7	69	1
18	5	74	2
19	5	77	2
20	5	78	1
21	4	79	2
23	3	80	3
24	5	83	1
25	2	88	1
26	4	90	2
27	5	92	1
28	3	96	1
29	3	100	1
30	5	102	2
31	4	103	1
32	1	105	1
33	2	109	1
34	3	115	1
35	2	122	1
36	2	123	1
37	2	131	1
38	3	139	2
39	1	166	1
40	2	170	2
41	1	174	1
42	2	178	1
43	1	182+	22
46	3		

TABLE 21 - CONTINUED.

	ACUTE	REHAB.	CONTINUING CARE	TOTAL
TOTAL	7407	3610	1274	12291
MEAN	31.3	15.2	5.4	51.9 DAYS
MEDIAN				30 DAYS

A TOTAL OF 55 FEMALE PATIENTS OUT OF 199 (27.6%) WERE TREATED ON THE REHABILITATION WARD.

5.1.2.8 TREATMENT OF PROXIMAL FEMORAL FRACTURES.

Table 22 summarises the primary treatment of the 237 proximal femoral fracture cases. Ninety per cent (213/237) were treated surgically. The choice of treatment was mainly determined by the type of proximal femoral fracture. Garden screws were mainly used for sub-capital fractures with little or no displacement. Hemi-arthroplasty (mainly with a Moore prosthesis) was the favoured treatment for displaced sub-capital fractures at Stockport Infirmary, although total hip replacement with a low friction arthroplasty was the preferred treatment at Wythenshawe hospital. A sliding compression screw plate or dynamic hip screw was the preferred treatment for trochanteric fractures. Of the patients treated surgically 98 per cent (209/213) had a general anaesthetic. Twenty-two of the 24 patients who were not treated surgically had medical complications which prevented them being made sufficiently fit for surgery. Nineteen of these patients died in hospital and the other 3 were still alive at 6 months. Of the other 2 patients treated non-surgically, one had had an above knee amputation on the

same side as the fracture, and the other had a grossly oedematous limb which was not suitable for surgery. Both of these patients were still alive at 6 months.

TABLE 22.

THE PRIMARY TREATMENT OF PROXIMAL FEMORAL FRACTURES IN STOCKPORT.

N=237.

PRIMARY TREATMENT	NUMBER
NON-SURGICAL	24
GARDEN SCREWS	68
BLADE PLATE	10
DYNAMIC HIP SCREW	78
THOMPSON HEMI-ARTHROPLASTY	2
MOORE HEMI-ARTHROPLASTY	36
TOTAL HIP REPLACEMENT	15
CONDYLO-CEPHALIC NAIL	1
OTHER	3

89.9% OF FRACTURES WERE TREATED SURGICALLY.

Table 23 shows the distribution of the interval between admission to hospital and primary treatment of the fracture. The modal interval for primary surgical treatment was treatment on the day following the fracture (42%). In a minority of patients (8%) treatment was delayed beyond 1 week following admission because of coincidental medical problems. The median time interval between admission to hospital and surgical treatment in those patients treated surgically was between 1 and 2 days.

TABLE 23.

THE INTERVAL BETWEEN ADMISSION TO HOSPITAL AND PRIMARY TREATMENT OF THE PROXIMAL FEMORAL FRACTURE.

N=237.

ADMISSION/PRIMARY TREATMENT INTERVAL (DAYS)	NUMBER
NOT APPLICABLE	24
SAME DAY (DAY 0)	7
FOLLOWING DAY (DAY 1)	90
DAY 2	59
DAY 3	24
DAY 4	12
DAY 5	2
DAY 6	2
DAY 7	3
DAY 8	2
DAY 9	2
DAY 10	2
DAY 11	2
DAY 12	1
DAY 13	1
DAY 23	1
DAY 30	2
DAY 40	1

Sixty-three per cent of the 237 fracture cases were complicated by medical problems in hospital. Of the 70 patients known to be dead by 6 months following the fracture, 64 died in hospital.

Table 24 summarises the complications experienced by 149/237 (63%) of patients in hospital. These 149 patients experienced 193

complications.

TABLE 24.

MEDICAL COMPLICATIONS IN HOSPITAL.

COMPLICATION.	NUMBER OF CASES.
Orthopaedic (unstable fixation)	24
Bronchopneumonia	22
Wound infection	17
Decubitus ulcer	15
Confusion	10
Thromboembolism	10
Diarrhoea	8
Cerebrovascular episode	8
Cardiac failure	8
Myocardial ischaemia/infarction	8
Dehydration	8
Anaemia	7
Fall in hospital	7
Urinary retention	5
Uraemia	4
Carcinomatosis	4
Intestinal obstruction	4
Urinary tract infection	3
Depression	3
Bacteraemia	3
Hypotension	2
Other	13

Table 25 shows that patients who had not had an active medical problem at the time of the fracture were no less likely to experience medical problems in hospital than patients with active medical problems.

TABLE 25.

THE RELATIONSHIP BETWEEN THE PRESENCE OF AN ACTIVE MEDICAL PROBLEM AT THE TIME OF FRACTURE AND COMPLICATIONS IN HOSPITAL.

		MEDICAL COMPLICATIONS IN HOSPITAL.			
		PRESENT	ABSENT	NOT KNOWN	TOTAL
MEDICAL PROBLEM BEFORE #	+	114	61	-	175
	-	35	26	-	61
	NK	-	-	1	1
TOTAL:		149	87	1	237

Chi-squared = 0.86
d.o.f. = 1
$0.3 < P < 0.4$.

Twenty-four out of 213 patients treated surgically had a technical problem causing instability of the fracture post-operatively. Seventeen (8%) of the 213 patients treated surgically had a further operation on the fracture within 6 months of the first admission to hospital. Another patient had 2 further operations on the fracture in the 6 months following the original admission. Seven of the further operations were total hip replacements.

5.1.2.9 OUTCOME AT 6 MONTHS FOLLOWING THE FRACTURE.

All but 3 of the 237 patients were followed up at 182 days following the fracture.

a. Mortality.

Table 26 summarises the survival time, t, in days of the 70 patients who were known to be dead at 6 months following the fracture. The 3 patients who were lost to follow-up are also included. The table summarises the calculation of the estimated probability of survival at 180 days following the fracture, based on the experience of all 237 patients, using the product limit method [129]. The estimated cumulative probability of survival at 180 days is 0.704 and the 95 per cent confidence limits are 0.646 to 0.762.

TABLE 26 - KAPLAN MEIER ESTIMATED SURVIVAL FOR 237 STOCKPORT RESIDENTS IN MAIN COHORT STUDY.

n = 237. + Censored survival time

SURVIVAL TIME t	RANK	r	(n-r)/(n-r+1)	(n-r)*(n-r+1) a.	1/a.	KAPLAN MEIER ESTIMATE
1	1	1	.99578	55932	.0000179	.99578
2	2	2	.99576	55460	.0000180	.99156
2	3	3	.99574	54990	.0000182	.98734
2	4	4	.99573	54522	.0000183	.98312
3	5	5	.99571	54056	.0000185	.97890
4	6	6	.99569	53592	.0000187	.97468
4	7	7	.99567	53130	.0000188	.97046
5	8	8	.99565	52670	.0000190	.96624
5	9	9	.99563	52212	.0000192	.96203
5	10	10	.99561	51756	.0000193	.95781
5	11	11	.99559	51302	.0000195	.95359
6	12	12	.99558	50850	.0000197	.94937
6	13	13	.99556	50400	.0000198	.94515
7	14	14	.99554	49952	.0000200	.94093
7	15	15	.99552	49506	.0000202	.93671
7	16	16	.99550	49062	.0000204	.93249
7	17	17	.99548	48620	.0000206	.92827
9	18	18	.99545	48180	.0000208	.92405
10	19	19	.99543	47742	.0000209	.91983
11	20	20	.99541	47306	.0000211	.91561
11	21	21	.99539	46872	.0000213	.91139
11	22	22	.99537	46440	.0000215	.90717
12	23	23	.99535	46010	.0000217	.90295
12	24	24	.99533	45582	.0000219	.89873
13	25	25	.99531	45156	.0000221	.89451
15	26	26	.99528	44732	.0000224	.89030
15	27	27	.99526	44310	.0000226	.88608
16	28	28	.99524	43890	.0000228	.88186
16	29	29	.99522	43472	.0000230	.87764
16	30	30	.99519	43056	.0000232	.87342
17	31	31	.99517	42642	.0000235	.86920
18	32	32	.99515	42230	.0000237	.86498
18	33	33	.99512	41820	.0000239	.86076
27	34	34	.99510	41412	.0000241	.85654
28	35	35	.99507	41006	.0000244	.85232
29	36	36	.99505	40602	.0000246	.84810
29	37	37	.99502	40200	.0000249	.84388
30	38	38	.99500	39800	.0000251	.83966
32	39	39	.99497	39402	.0000254	.83544
32	40	40	.99495	39006	.0000256	.83122
34	41	41	.99492	38612	.0000259	.82700
35	42	42	.99490	38220	.0000262	.82278
35	43	43	.99487	37830	.0000264	.81857
41	44	44	.99485	37442	.0000267	.81435
43	45	45	.99482	37056	.0000270	.81013
43+	46					
44	47	47	.99476	36290	.0000276	.80589
47	48	48	.99474	35910	.0000278	.80164
47	49	49	.99471	35532	.0000281	.79740

TABLE 26 CONTINUED - KAPLAN MEIER ESTIMATED SURVIVAL FOR 237 STOCKPORT RESIDENTS IN MAIN COHORT STUDY.

n = 237. + Censored survival time

SURVIVAL TIME t	RANK	r	(n-r)/(n-r+1)	(n-r)*(n-r+1) a.	1/a.	KAPLAN MEIER ESTIMATE
49	50	50	.99468	35156	.0000284	.79316
50	51	51	.99465	34782	.0000288	.78892
51	52	52	.99462	34410	.0000291	.78468
51	53	53	.99459	34040	.0000294	.78044
60	54	54	.99457	33672	.0000297	.77619
61	55	55	.99454	33306	.0000300	.77195
63	56	56	.99451	32942	.0000304	.76771
81	57	57	.99448	32580	.0000307	.76347
81	58	58	.99444	32220	.0000310	.75923
82	59	59	.99441	31862	.0000314	.75499
83	60	60	.99438	31506	.0000317	.75075
97	61	61	.99435	31152	.0000321	.74650
100	62	62	.99432	30800	.0000325	.74226
104	63	63	.99429	30450	.0000328	.73802
112	64	64	.99425	30102	.0000332	.73378
123	65	65	.99422	29756	.0000336	.72954
124	66	66	.99419	29412	.0000340	.72530
143+	67					
155	68	68	.99412	28730	.0000348	.72103
160+	69					
161	70	70	.99405	28056	.0000356	.71674
175	71	71	.99401	27722	.0000361	.71245
179	72	72	.99398	27390	.0000365	.70815
180	73	73	.99394	27060	.0000370	.70386
				TOTAL =	.0017813	

VARIANCE OF ESTIMATED SURVIVAL AT 180 DAYS = .0008825

STANDARD ERROR = .0297065

95% CONFIDENCE LIMITS = 0.646 TO 0.762

Table 27 summarises the main causes of death of these 70 patients.

TABLE 27.

MAIN CAUSES OF DEATH.

CAUSE OF DEATH	NUMBER OF PATIENTS	ICD CODE
BRONCHOPNEUMONIA	21	485
MYOCARDIAL INFARCTION	10	410
CARDIAC FAILURE	9	428
PULMONARY EMBOLISM	7	415.1
STROKE	4	436
METASTASTIC DISEASE	4	199
OTHER	8	-
NOT KNOWN	7	
TOTAL	70	

Femoral neck fracture, ICD code 820, was mentioned as a cause of death in 33 of 63 cases in which the certified cause of death could be traced.

b. Morbidity.

Fifty-two per cent of all 237 fracture cases had returned to their usual place of residence by 6 months following the fracture. In 46 per cent of the 237 cases the patient was either dead at 6 months or had moved to another residence because of increased dependency consequent upon the fracture. Of the 167 survivors, 23 (14%) could no longer live alone following the fracture. In 80 of

the 167 survivors (48%) the ability to perform the normal activities of daily living as measured by the dependency score had deteriorated during the 6 month period. In 7 per cent the dependency score had improved. In 108 survivors (65%) the score for walking ability had deteriorated over the 6 months following the fracture. The walking ability improved in only 2 people. For example, 48 people walked with a frame compared with 19 before the fracture. Only 28 (17%) were able to walk without assistance or walking aids compared with 57% before the fracture. At 6 months following the fracture 42 per cent (41/97) of people living in their own homes needed a local authority home help and 23 per cent (25/108) of people living in private households needed regular visits from the district nurse. Seventy-six per cent of survivors who could give sensible answers (111/146) reported that their activities were more limited at 6 months following the fracture and 67 per cent reported that their hip was still painful. Many of the survivors had become confined to their living quarters because of the hip fracture and lack of self-confidence was a prominent complaint. Thirty-two per cent of the survivors (53/167) had been able to climb a flight of stairs before the fracture without assistance but were no longer able to do so at 6 months following the fracture. Sixteen per cent (26/167) had been able to rise from a chair without assistance but were no longer able to do so.

5.1.3 THE RELATIONSHIP BETWEEN SELECTED CHARACTERISTICS OF THE PATIENTS BEFORE OR AT THE TIME OF THE FRACTURE AND OUTCOME.

Table 28 summarises the descriptive statistics for the 27 independent variables. It is not possible conveniently to reproduce the values for all 27 independent variables for all 292 cases. This table is a descriptive summary of the range of all variables and of the central tendency and scatter of the variables measured on interval or ratio scales of measurement.

TABLE 28.

DESCRIPTIVE STATISTICS FOR THE 27 INDEPENDENT VARIABLES.

VARIABLE.	MINIMUM	MAXIMUM	MEAN	S.D.
SEX	0	1		
FRACTURE TYPE	0	1		
FRACTURE MONTH	1	12		
FRACTURE/ADMISSION INTERVAL	0	32	0.98	2.84
AGE	38	99	78.19	17.12
LIVING ALONE	0	1		
RETIRED	0	1		
DRIVER	0	1		
PREVIOUS FRACTURE	0	1		
CLIMB STAIRS	0	1		
RISE FROM CHAIR	0	1		
WALKING ABILITY	1	7		
RESIDENCE	1	7		
MEDICAL PROBLEM	0	1		
DRUG TREATMENT	0	1		
DEPENDENCY SCORE	1	7		
HAEMOGLOBIN	6.1	18.6	12.34	6.54
PHOSPHATE	0.48	2.41	0.99	0.26
ALKALINE PHOSPHATASE	43	2580	139.93	231.97
ALBUMIN	19	45	35.38	3.97
CORRECTED CALCIUM	2.01	3.11	2.34	0.12
FRACTURE MECHANISM	1	11		
ADMISSION/TREATMENT INTERVAL	0	40	2.69	4.16
PRIMARY TREATMENT	1	11		
MENTAL TEST SCORE	0	35		
PRIMARY TREATMENT IN STOCKPORT	0	1		
STOCKPORT RESIDENT	0	1		

5.1.3.1 SURVIVAL - AN INDEX OF MORTALITY FOLLOWING THE FRACTURE.

a. Univariate analysis.

In this analysis the assocation between each independent variable and survival was examined individually. This analysis does not take account of interaction between the variables.

Table 29 summarises the results of the univariate analysis. Several variables were significantly associated with survival ($P <= 0.05$). The factors which were significantly associated with a worse prognosis included an extra-capsular fracture, a fracture occurring in a retired person, the presence of an active medical problem at the time of the fracture, regular drug treatment at the time of the fracture, a low blood haemoglobin concentration, advanced age, inability to climb stairs before the fracture, a high blood phosphate concentration and a low mental test score. There was significant heterogeneity between groups for certain grouped variables including walking ability before the fracture, the dependency score before the fracture, the fracture mechanism and primary treatment, indicating that the different groups within each of these 4 variables had different survival experiences.

TABLE 29.

THE RELATIONSHIP BETWEEN THE INDEPENDENT VARIABLES AND SURVIVAL - UNIVARIATE ANALYSIS.

N = 292.

VARIABLE.	NUMBER OF MISSING VALUES.	COX MANTEL C	SIGNIFICANCE.
SEX	0	-0.58	
FRACTURE TYPE	1	-2.45	*
FRACTURE MONTH	0	1.15	
FRACTURE ADMISSION INTERVAL	11	-0.36	
AGE LAST BIRTHDAY	0	2.79	*
LIVING ALONE BEFORE FRACTURE	0	-0.12	
RETIRED BEFORE FRACTURE	1	-2.24	*
DRIVER BEFORE FRACTURE	5	1.73	
PREVIOUS PROXIMAL FEMORAL FRACTURE	0	-1.16	
CLIMB STAIRS BEFORE FRACTURE	11	2.1	*
RISE FROM CHAIR BEFORE FRACTURE	11	1.69	
WALKING ABILITY BEFORE FRACTURE	12	N/A	**
USUAL RESIDENCE BEFORE FRACTURE	0	N/A	
ACTIVE MEDICAL PROBLEM	1	-3.25	*
REGULAR DRUG TREATMENT	1	-2.03	*
DEPENDENCY SCORE	10	N/A	**
BLOOD HAEMOGLOBIN	2	-3.33	*
BLOOD PHOSPHATE	20	2.76	*
BLOOD ALKALINE PHOSPHATASE	19	1.55	
BLOOD ALBUMIN	19	-1.52	
BLOOD CORRECTED CALCIUM	20	-0.054	
FRACTURE MECHANISM	4	N/A	**
ADMISSION-TREATMENT INTERVAL	27	1.27	
PRIMARY TREATMENT	0	N/A	**
MENTAL TEST SCORE	11	-3.56	*

TABLE 29 - CONTINUED.

VARIABLE.	NUMBER OF MISSING VALUES.	COX MANTEL C	SIGNIFICANCE.
TREATED IN STOCKPORT	0	-1.93	
STOCKPORT RESIDENT	0	0.52	

N/A = Not applicable.

* $P < 0.05$

** $P < 0.05$ (KRUSKAL WALLIS TEST).

b. Multivariate analysis.

This analysis examined the joint effects of the 27 independent variables and identified those variables which had an association with survival which was independent of any interaction between the variables.

In the preliminary analysis, with all 27 co-variates in the model, 61 out of 292 cases (21%) had missing values for at least 1 of the 27 variables. Following this preliminary analysis a further analysis included 10 of the original 27 co-variates and an additional 4 variables which were created by transforming the original variables. The patient's walking ability before the fracture was treated as a dichotomous variable (1 - able to walk without assistance or a mechanical aid, 0 - unable to walk without assistance or a mechanical aid). The month in which the fracture occurred was treated as a dichotomous variable (1 - Winter months of October to March, 2 - Summer months of April to September). The mechanism of the fracture was also treated as a dichotomous variable (1 - fall in public place, 0 - other). A new variable, the calcium-phosphate product, was created by multiplying the value for

the blood corrected calcium level by the blood phosphate level. Thus the 14 variables which were included as co-variates in the further analysis and which were progressively eliminated using the backward stepwise procedure were: sex, fracture type, age, residence before the fracture, history of an active medical problem at the time of fracture, dependency score, blood phosphate level, mental test score, ability to walk unaided, season during which the fracture occurred, whether the patient fell in a public place, calcium-phosphate product, whether the patient was a Stockport resident, and whether the patient was treated in Stockport. In this further analysis, 34 of the 292 cases (11.6%) had missing values for at least 1 of the 14 co-variates.

Table 30 summarises the results of the analysis and lists the significant variables ($P <= 0.05$) in order of their significance together with the estimated regression coefficients $b1, \ldots, bp$ where $p = 5$. A positive coefficient indicates a significant positive association with the hazard survivorship function or, in other words, a negative association with survival limited to 6 months. Similarly, a negative coefficient indicates a significant positive association with survival.

TABLE 30.

EFFECT OF INDEPENDENT VARIABLES ON SURVIVAL - MULTIVARIATE ANALYSIS USING COX'S PROPORTIONAL HAZARD MODEL.

N = 258 (out of 292 total)

PROGNOSTIC VARIABLES	REGRESSION COEFFICIENT	SIGNIFICANCE LEVEL	MAXIMUM LOG LIKELIHOOD
PHOSPHATE	1.98	$P<0.001$	-400.3
MED PROBLEM	0.82	$0.01<P<0.012$	-393.45
MENTAL SCORE	-0.03	$0.01<P<0.012$	-392.72
FALL IN PUBLIC	-1.26	$0.016<P<0.018$	-393.71
AGE	0.04	$0.018<P<0.02$	-392.6

Table 31 lists the estimated relative risks for each of the significant variables. The risks for favourable and unfavourable values of each variable, with the other 4 variables being held at their mean values, are expressed relative to the risk for an individual with values for all 5 variables equal to the mean values. The final column indicates the estimated ratio of the risk for an unfavourable value of each variable to the risk for a favourable value, with the other 4 variables being held at their mean values.

TABLE 31.

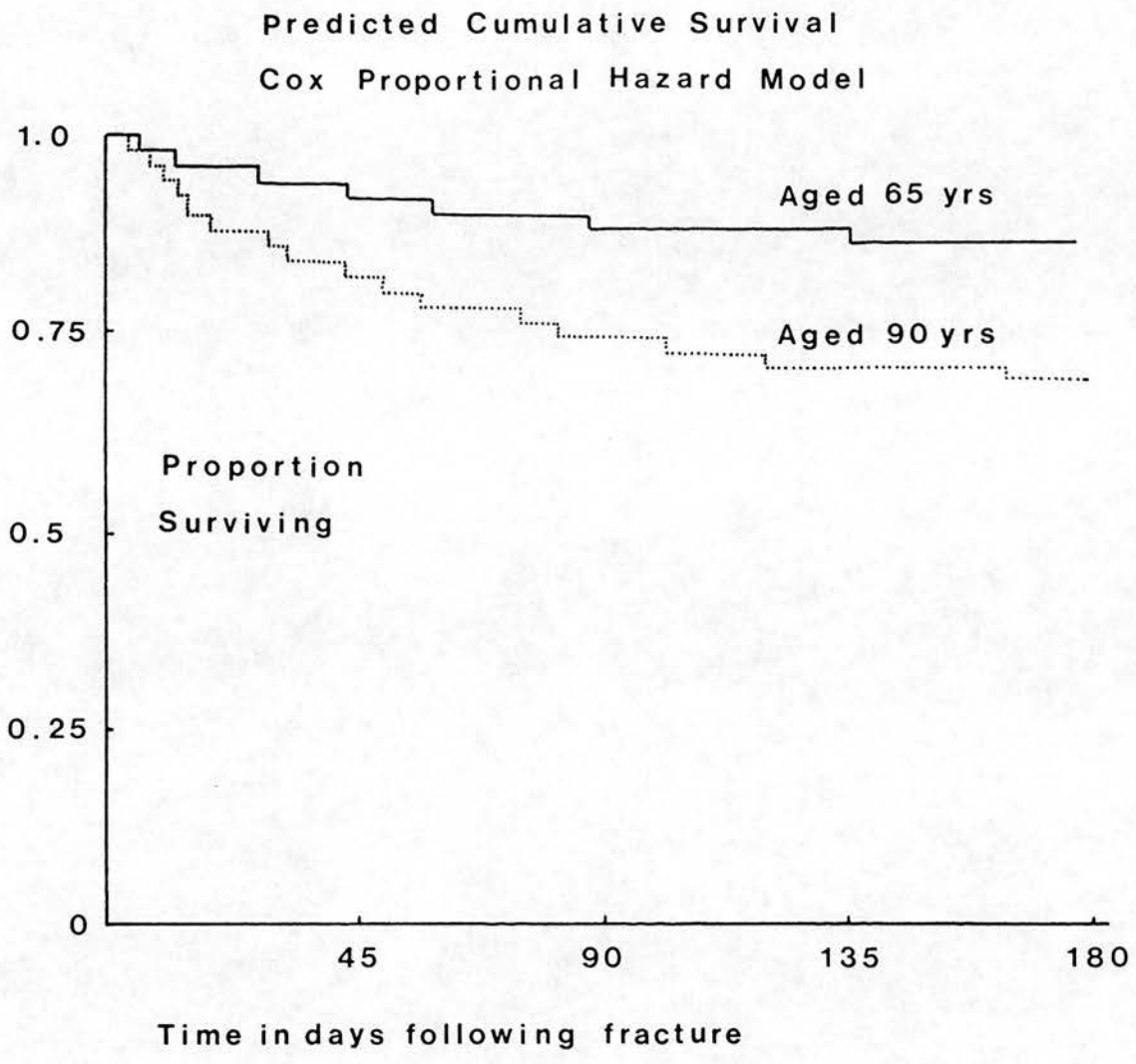
EFFECT OF INDEPENDENT VARIABLES ON SURVIVAL - RELATIVE RISKS FOR EACH VARIABLE.

N = 258 (out of 292 total)

PROGNOSTIC VARIABLE	FAVOURABLE VALUE	UNFAVOURABLE VALUE	RELATIVE RISK. FAVOURABLE.	RISK. UNFAVOURABLE.	RATIO OF RISKS.
PHOSPHATE	0.5	2.4	0.38	16.35	43.08
MEDICAL PROBLEM	0	1	0.56	1.26	2.26
MENTAL SCORE	35	0	0.72	1.77	2.46
FALL IN PUBLIC PLACE	1	0	0.37	1.31	3.51
AGE	65	90	0.6	1.51	2.52

Figure 5 illustrates, for example, the increased relative risk for people of advanced age. Survival curves, as predicted by the model, for two groups of individuals differing only in age at the time of the fracture (65 years compared with 90 years), with the other significant variables being held at their mean values, are shown.

FIG 5


Predicted Cumulative Survival
Cox Proportional Hazard Model
1.0
0.75
0.5
0.25
0
Aged 65 yrs
Aged 90 yrs
Proportion
Surviving
45
90
135
180
Time in days following fracture

The significant variables included in the final regression were blood phosphate level at the time of admission to hospital, a history of an active medical problem at the time of the fracture, mental test score on admission to hospital, whether the injury was associated with a fall in a public place, and age at the time of the fracture. A high mental test score and a history of fracture occurring in association with a fall in a public place were positively associated with survival limited to 6 months. A high blood phosphate level, advanced age and a history of an active medical problem at the time of the fracture were all negatively associated with survival.

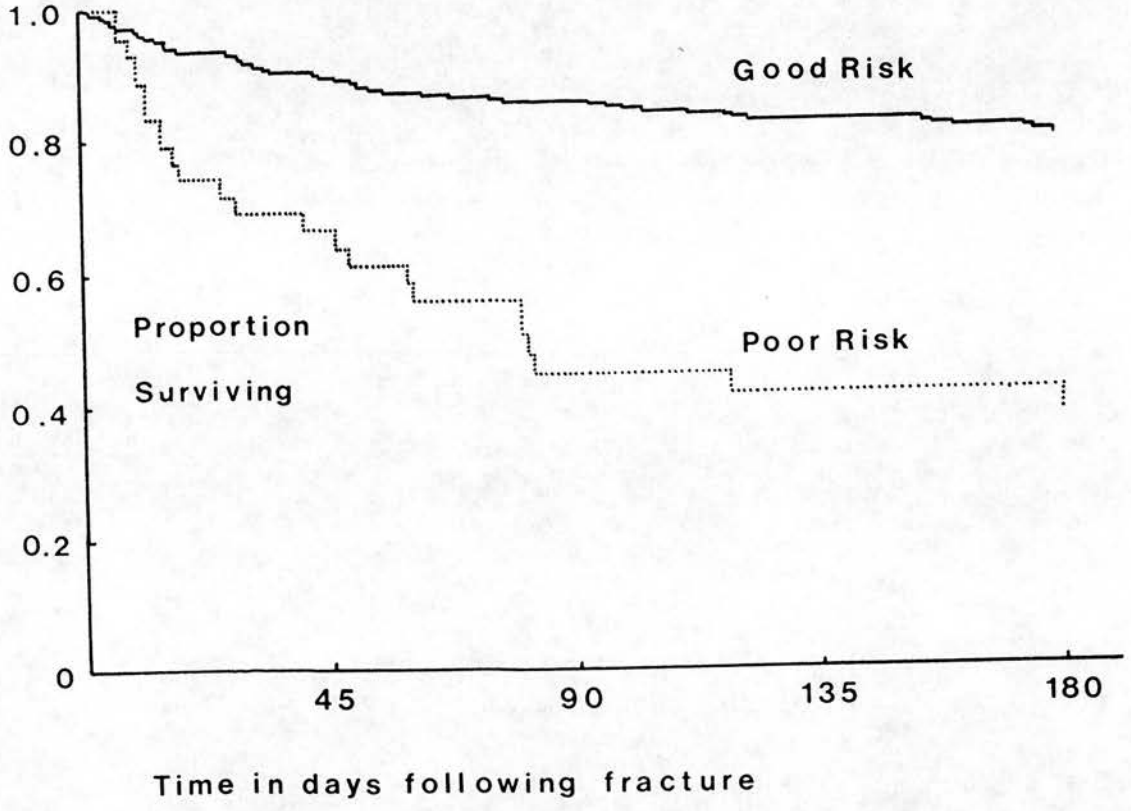
The regression was used arbitrarily to identify a `poor risk´ group of patients with respect to survival. This group included patients with a blood phosphate level greater than or equal to 0.8 mM/l, whose fracture was not associated with a fall in a public place, who gave a history of an active medical problem at the time of the fracture and who had a mental test score on admission to hospital of less than 16 out of a possible maximum of 35. This group included 38 cases or 13 per cent of the total cases. The model predicted survival for this group of 38 per cent at 179 days following the fracture, compared with a predicted survival of 80 per cent at 178 days following the fracture in the remaining favourable risk group.

Figure 6 illustrates graphically the difference in predicted survival for the poor risk and favourable groups. The predicted survival is plotted against time in days from the fracture up to 182 days.

FIG 6

Predicted Cumulative Survival

Cox Proportional Hazard Model



The model was used to examine the effects of different primary treatments on survival.

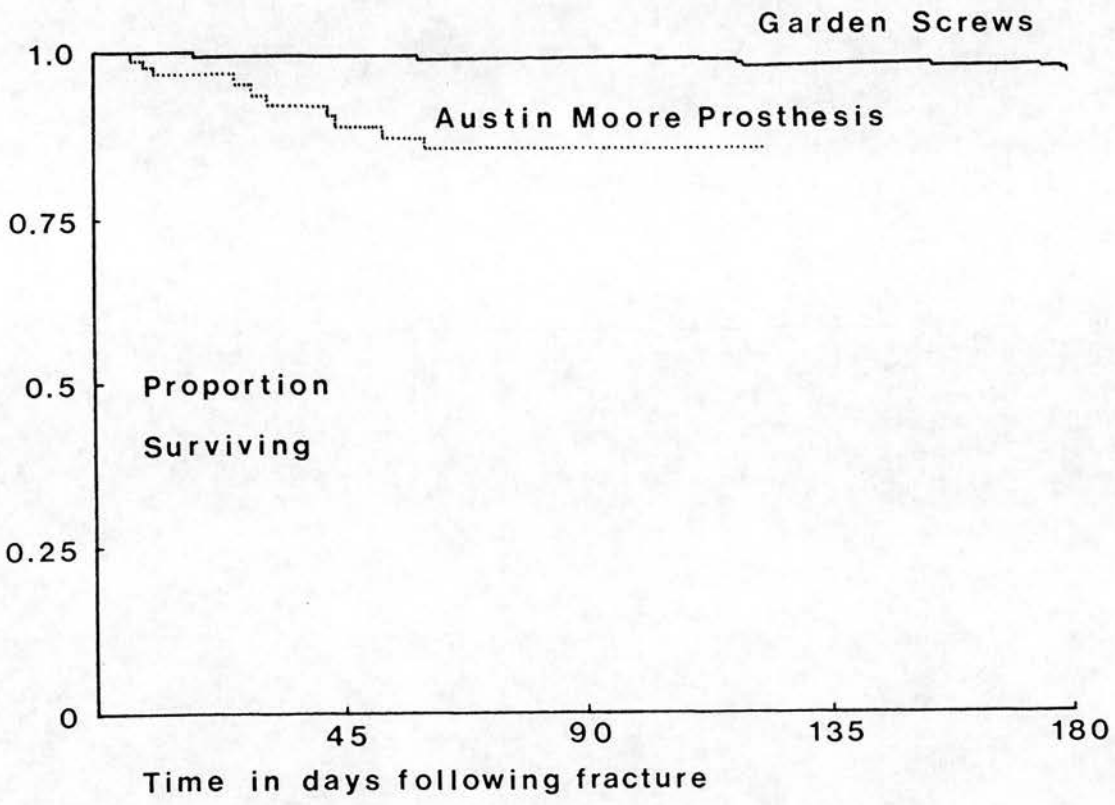
Figure 7 illustrates the predicted survival curves of patients with intra-capsular fractures treated with Garden screws and Austin Moore prosthesis.

The regression was re-calculated using only the 115 cases treated either with Garden screws or with an Austin Moore prosthesis and including primary treatment as a co-variate. Although the plotted survival curves suggest that the survival is better in the group treated with Garden screws, this effect was not, in fact, statistically significant.

FIG 7

Predicted Cumulative Survival

Cox Proportional Hazard Model



5.1.3.2 WALKING ABILITY AT 6 MONTHS - AN INDEX OF MORBIDITY FOLLOWING THE FRACTURE.

In the preliminary analysis, 8 independent variables were found to have a statistically significant effect ($P <= 0.05$) on the outcome in terms of walking ability at 6 months. These variables were sex, mental test score, walking ability before the fracture, dependency score before the fracture, the interval between admission to hospital and primary treatment, whether the patient could drive a car before the fracture, whether the patient could climb a flight of stairs unaided and whether the patient lived in Stockport. These co-variates were used in the further analysis. In this further analysis, patients who were dead at the time of follow-up, 182 days following the fracture, were excluded leaving a possible total of 203 cases.

Fifteen of the 203 cases (7.4%) had missing values for at least 1 of the 8 variables and were excluded from the analysis.

Table 32 summarises the linear logistic regression.

TABLE 32.

THE EFFECT OF THE INDEPENDENT VARIABLES ON THE OUTCOME AS JUDGED BY WALKING ABILITY AT 6 MONTHS - LINEAR LOGISTIC REGRESSION METHOD.

N = 188 (out of 203 total)

TERM		COEFFICIENT.	STANDARD ERROR.	COEFFICIENT/ STANDARD ERROR.
SEX		0.927	0.274	3.388
DRIVER		0.769	0.323	2.377
CLIMB STAIRS		0.794	0.387	2.050
WALKING BEFORE FRACTURE	1	10.793	6.815	1.584
	2	-0.831	0	0
	3	0.954	1.986	0.481
	4	0.547	1.81	0.302
	5	-6.767	0	0
	6	-1.488	1.81	-0.8
DEPENDENCY SCORE	1	3.357	1.453	2.309
	2	0.663	0.855	0.776
	3	-1.018	1.384	-0.736
	4	-1.507	0.802	-1.879
	5	-0.598	0.682	-0.876
	6	-1.525	0.639	-2.384
ADMISSION-TREATMENT INTERVAL		-0.276	0.145	-1.911
STOCKPORT RESIDENT		-0.736	0.313	-2.348
CONSTANT		2.197	1.736	1.266

The computer programme generates design variables for all categorical variables (i.e. variables which are measured on either a nominal or an ordinal scale of measurement) and their interactions. The design variables for each categorical variable are considered as a set. For each categorical variable, the set of design variables was added to or taken from the model at each step. For example, for the 7 possible scores for walking ability before the fracture, the programme generated 6 design variables which were used in the model in place of the category number. These generated design variables contrast the first category with the other 6 and the coefficients in the table relate to the 6 design variables. Seven variables: sex, whether the patient was a driver before the fracture, whether the patient could climb a flight of stairs unaided before the fracture, walking ability before the fracture, dependency score before the fracture, the interval between admission to hospital and primary treatment, and whether the patient lived in Stockport, were included in the final regression together with a constant.

Predicted probabilities of `success´ (i.e. able to walk at 6 months following the fracture as well as, or better than, before the fracture) were computed for each of the 188 cases included in the model.

Table 33 summarises the ability of the model to predict the outcome in terms of walking ability 6 months following the fracture. The cases were arranged in 5 groups according to their predicted probability values for a successful outcome. Using the observed number of successes a chi squared statistic was calculated to test the goodness of fit of the model to the data. A value for chi squared of 15.8 with 4 degrees of freedom was obtained ($P < 0.01$) indicating that there were highly significant discrepancies between the observed and predicted numbers of successes. This would

suggest that the model was not a good predictor of a successful outcome in terms of morbidity in those patients who were not dead at 6 months following the fracture.

TABLE 33.

THE ABILITY OF THE LINEAR LOGISTIC REGRESSION MODEL TO PREDICT OUTCOME IN TERMS OF WALKING ABILITY AT 6 MONTHS FOLLOWING THE FRACTURE.

N = 188 (out of 203 total)

PREDICTED PROBABILITY OF FAILURE	TOTAL NUMBER OF PATIENTS	OBSERVED NUMBER OF SUCCESSES	PREDICTED NUMBER OF SUCCESSES a.	O-E	$(O-E)^2$ b.	b/a.
0-	38	1	3.01	-2.01	4.04	1.34
0.0534-	38	4	12.41	-8.41	70.73	5.70
0.1949-	30	7	2.55	4.45	19.80	7.77
0.2961-	48	18	16.38	1.62	2.62	0.16
0.6072-	34	27	22.65	4.35	18.92	0.84
TOTAL	188	57	57	CHI SQ = 15.80		
				DOF =		4.00
				P < 0.01		

The predicted outcome according to the linear logistic regression model can be compared with the observed outcome using a classification matrix:

		PREDICTED OUTCOME.	
		SUCCESS.	FAILURE.
OBSERVED OUTCOME.	SUCCESS.	A	B
	FAILURE.	C	D

The marginal totals (A + B) and (C + D) are fixed and represent the observed number of successes and failures (57 and 131, respectively). The model makes it possible to calculate a value for the predicted probability of a successful outcome for each of the 188 cases (on a scale ranging between 0 and 1). The cut-off point for predicting success is chosen arbitrarily. For example, it may be decided that the model predicts a successful outcome if the predicted probability of success is equal to or greater than 0.5. The numbers in each cell of the classification matrix will clearly vary as the cut-off point used for predicting success varies.

One way of deciding which cut-off point might be used is to construct a `cost´ matrix:

		PREDICTED OUTCOME	
		SUCCESS.	FAILURE.
OBSERVED OUTCOME	SUCCESS	0	-1
	FAILURE	-1	0

In this matrix each incorrect prediction is given a score of minus 1 and each correct prediction a score of 0. The product of the classification matrix and the cost matrix can be regarded as the `loss function' and this will clearly vary as the cut-off point of predicted probability varies.

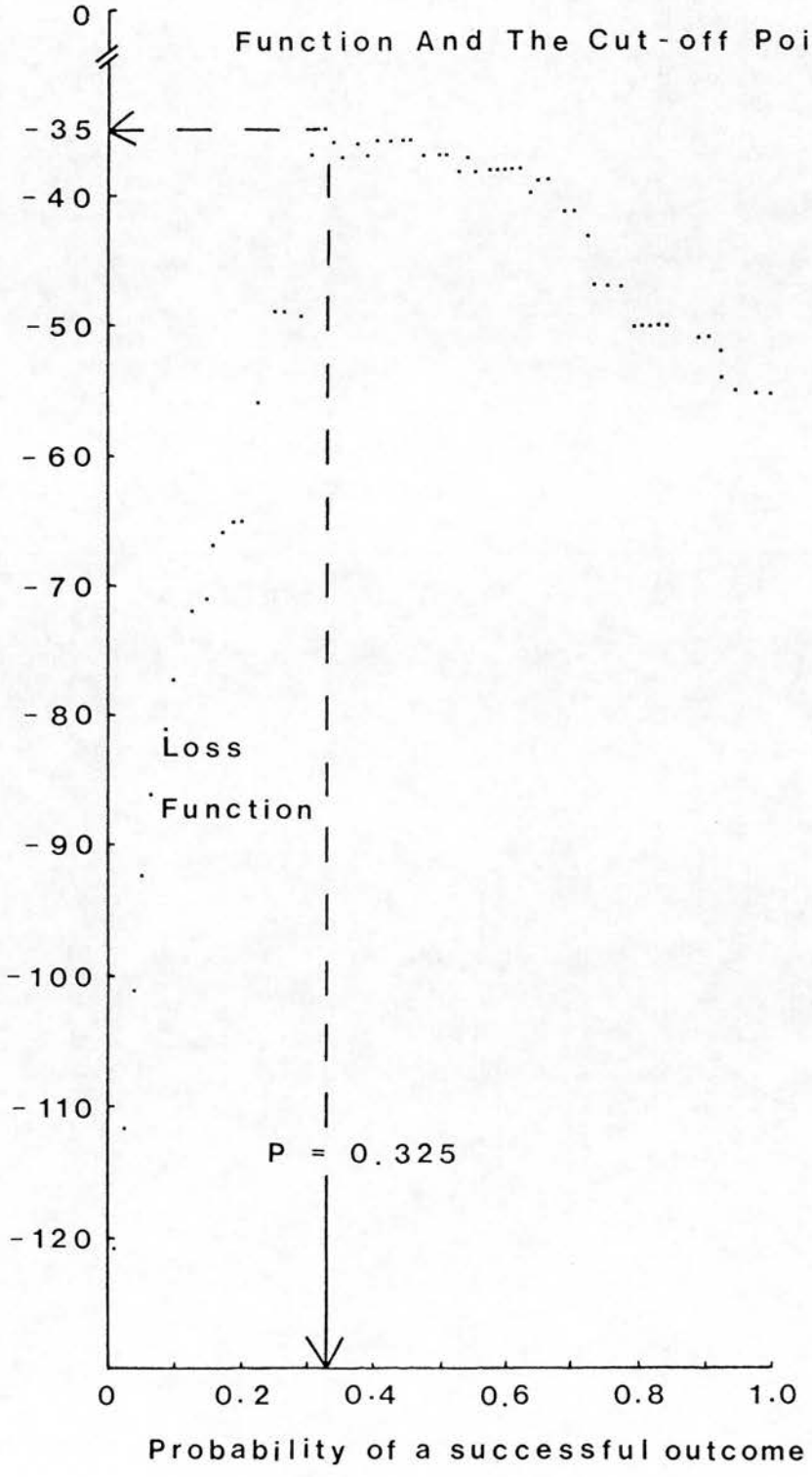
Figure 8 illustrates graphically how the loss function varies with the cut-off point. It can be seen that the loss function is at a minimum when the cut-off point is at 0.325.

The cell values at this cut-off point are as follows:

		PREDICTED OUTCOME		
		SUCCESS	FAILURE	TOTAL.
OBSERVED OUTCOME	SUCCESS	41	16	57
	FAILURE	19	112	131
TOTAL		60	128	188

FIG 8

The Relationship Between The Loss Function And The Cut-off Point



The loss function takes a value of (-19 + -16) or minus 35. Using the value P = 0.325 for the cut-off point, 72 per cent of successful outcomes (41/57) are correctly predicted and 85 per cent of unsuccessful outcomes (112/131) are correctly predicted. This is the value which maximises both the `sensitivity´ and the `specificity´ of the model in predicting a successful outcome.

5.1.4 COMPARISON WITH THE GENERAL SURVIVAL EXPERIENCE OF ELDERLY PEOPLE IN STOCKPORT.

Table 34 is the life table for proximal femoral fracture patients aged 65 years and older resident in Stockport for the 6 months following the fracture.

TABLE 34.

CUMULATIVE SURVIVAL OF STOCKPORT PATIENTS WITH PROXIMAL FEMORAL FRACTURE AGED 65 YEARS AND OLDER - LIFE TABLE METHOD.

A. INT. (DAYS)	B. LOST FU (NO)	C. WITHDR. (NO)	D. DEATHS (NO)	E. NO AT START	F. NO AT RISK	G. COND. PROPN. DYING	H. COND. PROPN. SURV.ING	I. CUM. PERCENT. SURV.ING
								100.00
0-	0	0	20	293	293	.07	.93	93.17
7-	0	0	12	273	273	.04	.96	89.08
14-	0	0	12	261	261	.05	.95	84.98
21-	1	0	5	249	248.5	.02	.98	83.27
28-	0	0	10	243	243	.04	.96	79.85
35-	0	0	4	233	233	.02	.98	78.48
42-	1	0	6	229	228.5	.03	.97	76.41
49-	0	0	4	222	222	.02	.98	75.04
56-	0	0	4	218	218	.02	.98	73.66
63-	1	0	0	214	213.5	0	1.00	73.66
70-	0	0	2	213	213	.01	.99	72.97
77-	0	0	4	211	211	.02	.98	71.59
84-	0	0	0	207	207	0	1.00	71.59
91-	0	0	1	207	207	0	1.00	71.24
98-	0	0	3	206	206	.01	.99	70.20
105-	0	0	1	203	203	0	1.00	69.86
112-	0	0	0	202	202	0	1.00	69.86
119-	1	0	2	202	201.5	.01	.99	69.16
126-	0	0	0	199	199	0	1.00	69.16
133-	0	0	1	199	199	.01	.99	68.82
140-	0	0	0	198	198	0	1.00	68.82
147-	0	0	1	198	198	.01	.99	68.47
154-	1	0	1	197	196.5	.01	.99	68.12
161-	0	0	0	195	195	0	1.00	68.12
168-	0	0	1	195	195	.01	.99	67.77
175-	0	0	2	194	194	.01	.99	67.07

This table summarises the survival experience of 293 Stockport residents aged 65 years and over identified during the 18 month study period (i.e. both the pilot and the main study).

COLUMN A : The time interval in days from the fracture.

COLUMN B : The numbers of patients lost to follow-up in each interval.

COLUMN C : The numbers of withdrawals in each interval.

COLUMN D : The numbers of deaths in each interval.

COLUMN E : The numbers of cases known to be alive at the start of each interval.

COLUMN F : The numbers of cases at risk in each interval E- 0.5(B + C).

COLUMN G : The conditional proportion dying during each interval.

COLUMN H : The conditional proportion surviving each interval.

COLUMN I : The cumulative percentage survival at the end of each interval.

Table 35 is the life table for the general Stockport population aged 65 years and over for a period of 6 months.

The cumulative percentage of proximal femoral fracture patients surviving at 6 months following the fracture is 67 per cent and this compares with a cumulative percentage survival for the general elderly population of 97 per cent at 6 months.

TABLE 35.

SURVIVAL OF GENERAL ELDERLY POPULATION [AGED 65 YEARS AND OVER] OF STOCKPORT OVER A 6-MONTH PERIOD USING A LIFE TABLE METHOD.

A. INT. (DAYS)	B. LOST FU (NO)	C. WITHDR. (NO)	D. DEATHS (NO)	E. NO AT START	F. NO AT RISK	G. COND. PROPN. DYING	H. COND. PROPN. SURV.ING	I. CUM. PERCENT. SURV.ING
								100.0000
0-	0	0	33	41200	41200	.0008	.9992	99.9199
7-	0	0	40	41167	41167	.0010	.9990	99.8228
14-	0	0	52	41127	41127	.0013	.9987	99.6966
21-	0	0	31	41075	41075	.0008	.9992	99.6214
28-	0	0	33	41044	41044	.0008	.9992	99.5413
35-	0	0	42	41011	41011	.0010	.9990	99.4393
42-	0	0	33	40969	40969	.0008	.9992	99.3592
49-	0	0	34	40936	40936	.0008	.9992	99.2767
56-	0	0	41	40902	40902	.0010	.9990	99.1772
63-	0	0	44	40861	40861	.0011	.9989	99.0704
70-	0	0	29	40817	40817	.0007	.9993	99.0000
77-	0	0	30	40788	40788	.0007	.9993	98.9272
84-	0	0	42	40758	40758	.0010	.9990	98.8252
91-	0	0	31	40716	40716	.0008	.9992	98.7500
98-	0	0	38	40685	40685	.0009	.9991	98.6578
105-	0	0	42	40647	40647	.0010	.9990	98.5558
112-	0	0	35	40605	40605	.0009	.9991	98.4709
119-	0	0	45	40570	40570	.0011	.9989	98.3617
126-	0	0	57	40525	40525	.0014	.9986	98.2233
133-	0	0	48	40468	40468	.0012	.9988	98.1068
140-	0	0	45	40420	40420	.0011	.9989	97.9976
147-	0	0	38	40375	40375	.0009	.9991	97.9053
154-	0	0	46	40337	40337	.0011	.9989	97.7937
161-	0	0	36	40291	40291	.0009	.9991	97.7063
168-	0	0	48	40255	40255	.0012	.9988	97.5898
175-	0	0	65	40207	40207	.0016	.9984	97.4320

Figure 9 illustrates graphically the survival experience of patients aged 65 years and over with proximal femoral fractures limited to 6 months following the fracture together with the survival experience limited to 6 months of the general elderly population (aged 65 years and over) in Stockport.

Table 36 shows the results of a similar life table estimated cumulative survival at 6 months for patients with proximal femoral fracture, compared with the general elderly population, broken down into 3 age-groups: 65 to 74 years, 75 to 84 years, and 85 years and over.

FIG 9

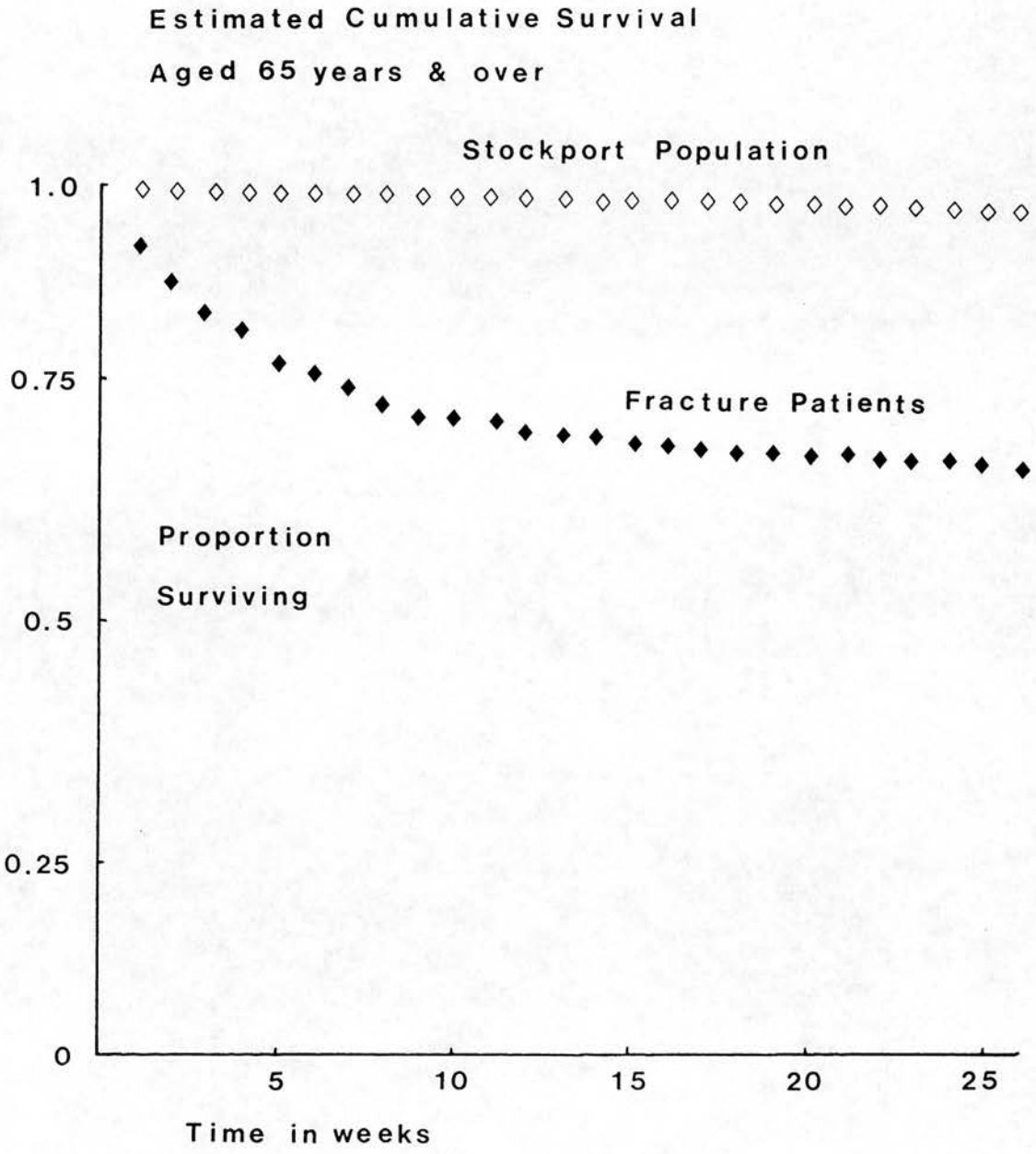

Estimated Cumulative Survival
Aged 65 years & over
Stockport Population
Fracture Patients
Proportion
Surviving
1.0
0.75
0.5
0.25
0
5
10
15
20
25
Time in weeks

TABLE 36.

ESTIMATED CUMULATIVE SURVIVAL TO 6 MONTHS OF STOCKPORT RESIDENTS WITH PROXIMAL FEMORAL FRACTURE COMPARED WITH SURVIVAL TO 6 MONTHS OF THE GENERAL POPULATION BY AGE-GROUP.

AGE-GROUP. YEARS.	PATIENTS WITH PROXIMAL FEMORAL FRACTURES.	GENERAL POPULATION.
65 TO 74.	76.7	98.7
75 TO 84.	72.4	96.6
85 YEARS +	52.2	91.6

Figures 10, 11 and 12 illustrate the different survival experience of proximal femoral fracture patients and the general population for the 3 age-groups over the entire 6 month period following the fracture.

FIG 10

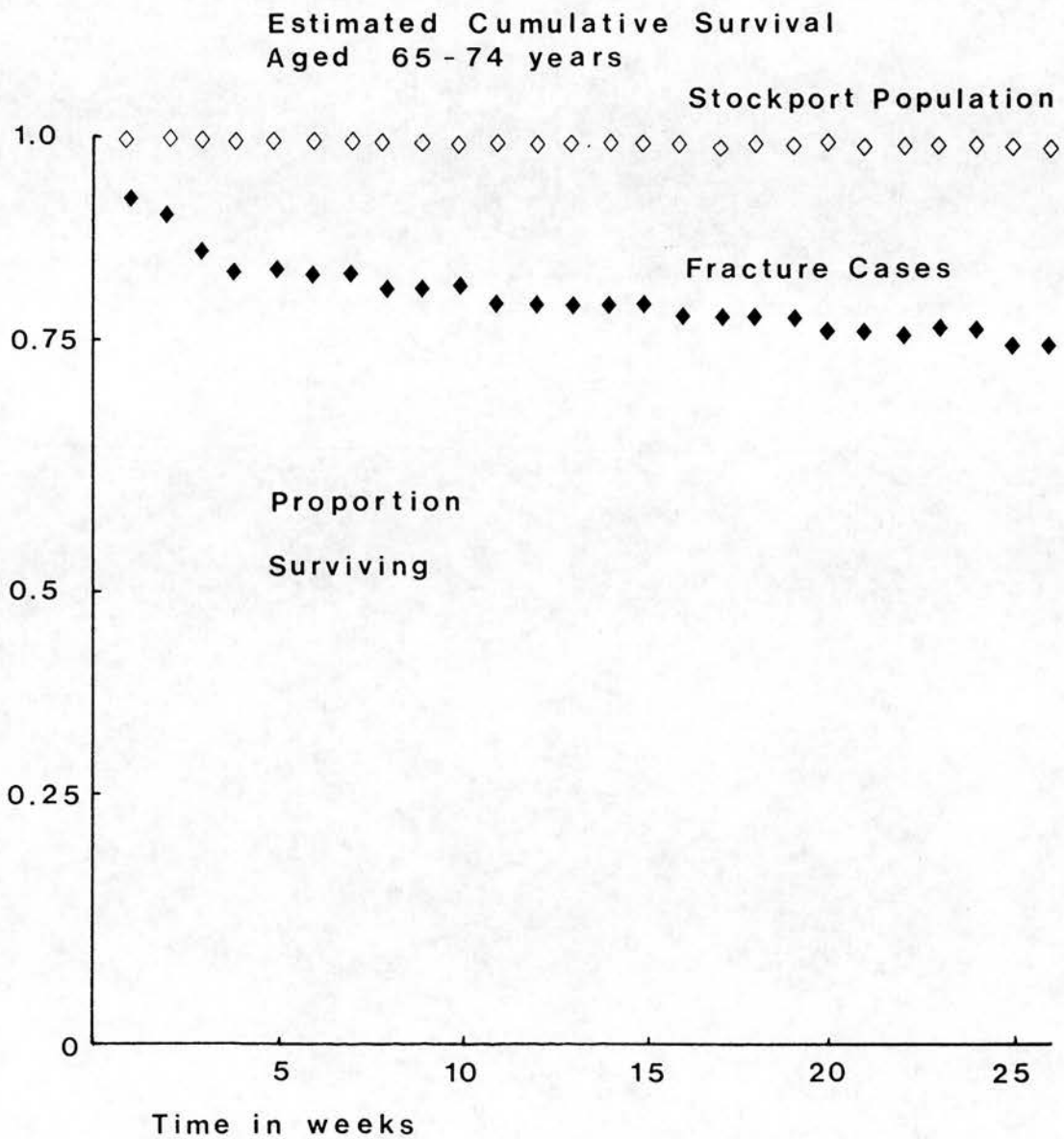

Estimated Cumulative Survival
Aged 65 - 74 years
Stockport Population
Fracture Cases
Proportion
Surviving
1.0
0.75
0.5
0.25
0
5
10
15
20
25
Time in weeks

FIG 11

Estimated Cumulative Survival

Aged 75 to 84 years

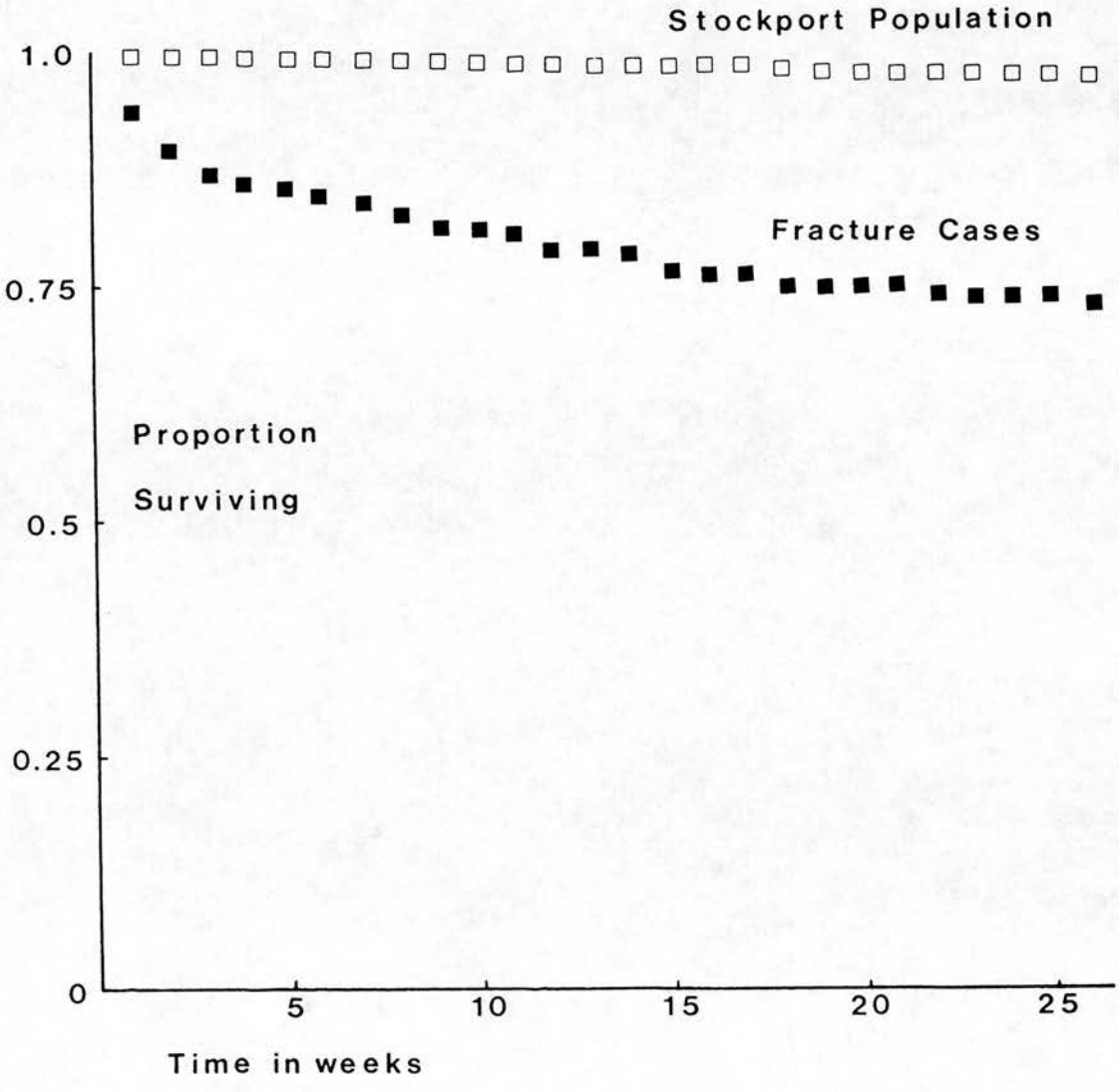
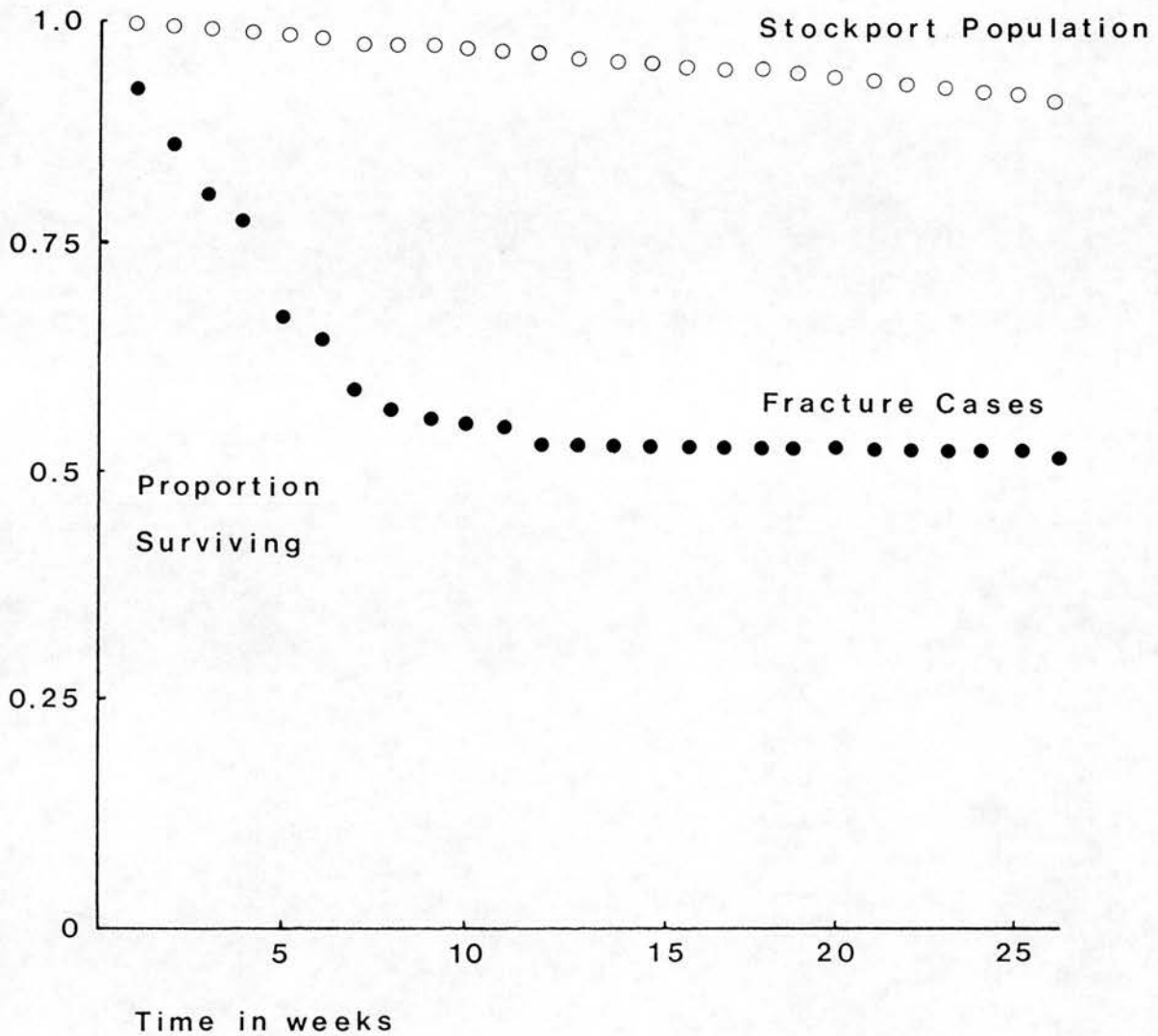


FIG 12

Estimated Cumulative Survival

Aged 85 years and over



5.2 THE ASSESSMENT OF RECENT TRENDS IN THE EFFICIENCY OF HOSPITAL CARE FOR PROXIMAL FEMORAL FRACTURES IN ENGLAND AND WALES.

Table 37 summarises the data.

Figure 13 shows that the standardised death rates for femoral neck fractures in elderly people in England and Wales have decreased consistently between 1968 and 1983.

Figure 14 shows that the hospital fatality ratio for femoral neck fractures in people aged seventy-five years and older has decreased over the period: the slope of the regression line is -0.29 and the difference between this and 0 is highly significant ($p<0.01$). However there has been no significant reduction in hospital fatality for people aged 65 to 74 years: the slope is -0.04 which is not significantly different from 0 ($0.5<p<0.6$).

Figure 15 shows that there has been a significant reduction in mean durations of hospital stay for people aged seventy-five years and older (slope = -0.29, $0.02<p<0.05$) and a highly significant reduction for people aged 65 to 74 years (slope = -0.51, $p<0.01$).

TABLE 37.

TRENDS IN THE STANDARDISED ANNUAL DEATH RATE, THE HOSPITAL FATALITY RATIO AND MEAN DURATIONS OF HOSPITAL STAY FOR FEMORAL NECK FRACTURE, ICD CODE 820, IN ENGLAND AND WALES.

YEAR	STANDARDISED ANNUAL DEATH RATE/100,000 AGED 65+ YRS.	HOSPITAL FATALITY RATIO (PERCENTAGE)		MEAN DURATIONS OF HOSPITAL STAY (DAYS)	
		65-74 YRS	75 YRS+	65-74 YRS	75 YRS+
1968	34.7	8.1	23.7	36.0	46.0
1969	34.0	7.9	23.6	36.4	47.5
1970	32.7	8.2	23.9	33.5	43.2
1971	30.2	8.8	23.0	36.7	43.7
1972	28.7	8.5	25.4	34.6	44.3
1973	28.4	8.8	23.0	36.4	42.9
1974	27.2	10.2	25.0	33.7	41.3
1975	27.4	9.4	24.0	36.1	40.5
1976	24.9	8.0	21.7	33.9	42.6
1977	25.3	7.6	23.5	29.3	42.1
1978	23.3	8.2	21.5	31.0	45.5
1979	22.7	8.9	21.7	32.0	41.2
1980	20.6	6.2	20.6	30.0	40.9
1981	18.5	8.8	19.7	30.0	42.9
1982	16.7				
1983	17.5				

FIG 13

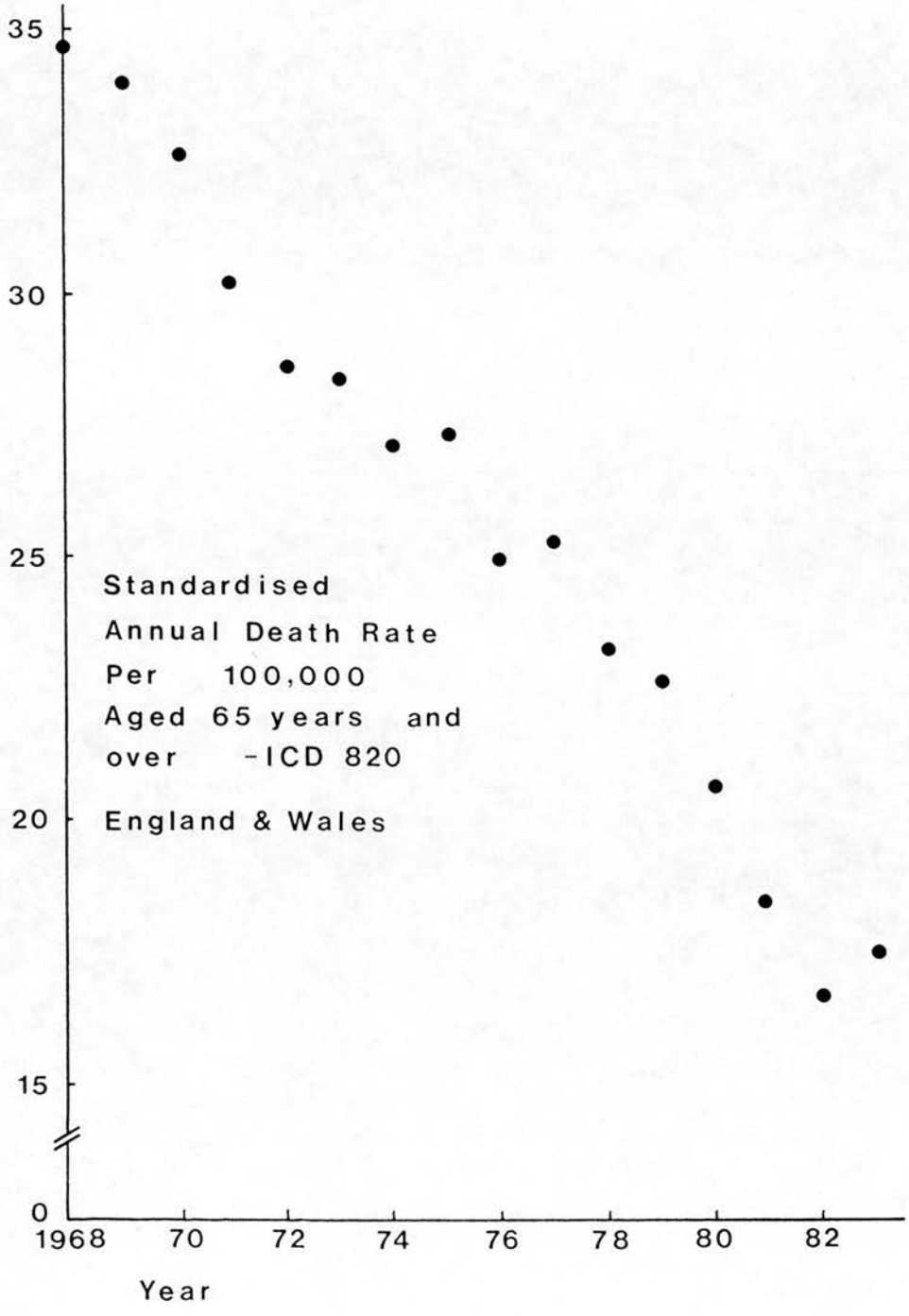

35
30
25
20
15
0
Standardised
Annual Death Rate
Per 100,000
Aged 65 years and
over -ICD 820
England & Wales
1968
70
72
74
76
78
80
82
Year

FIG 14

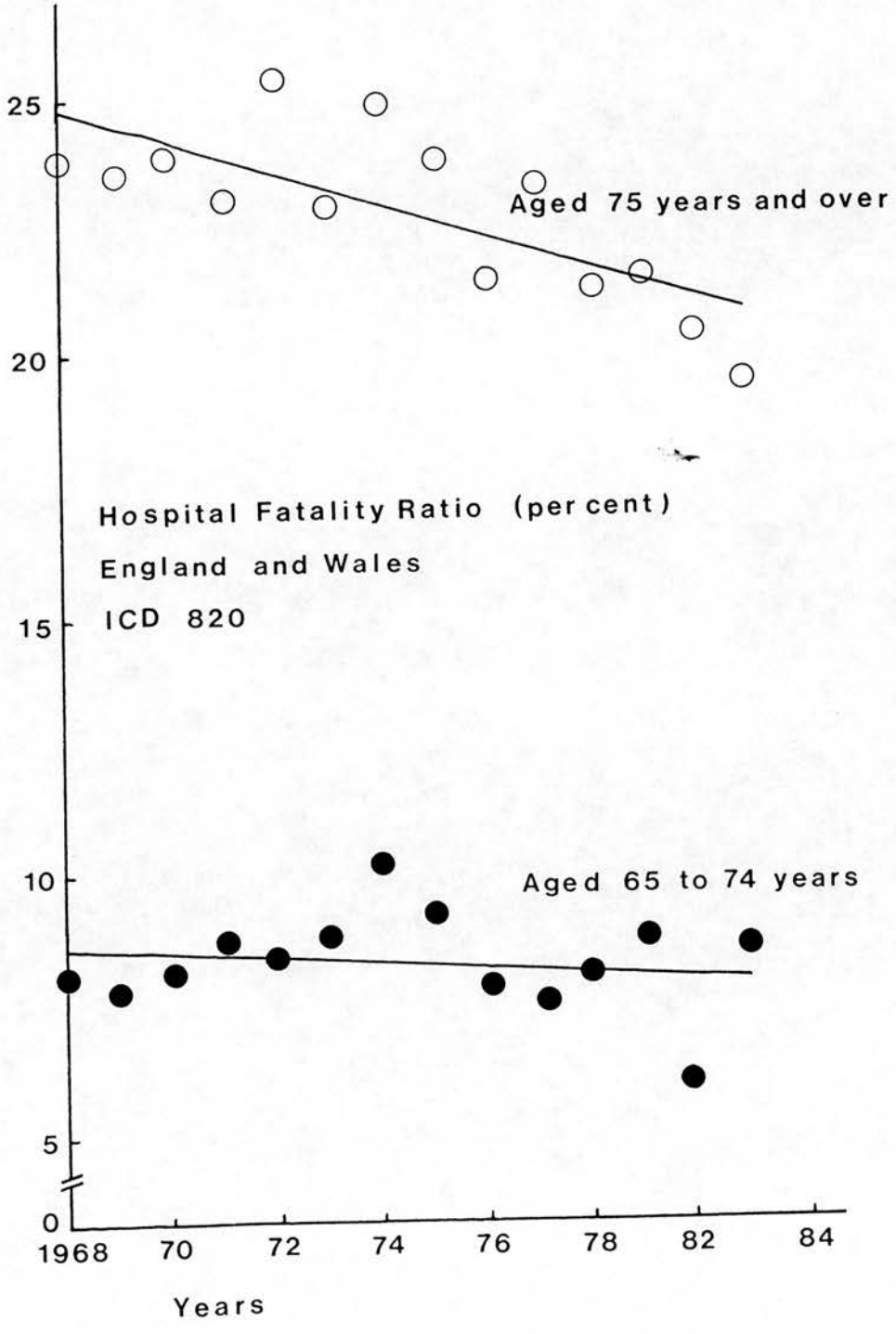
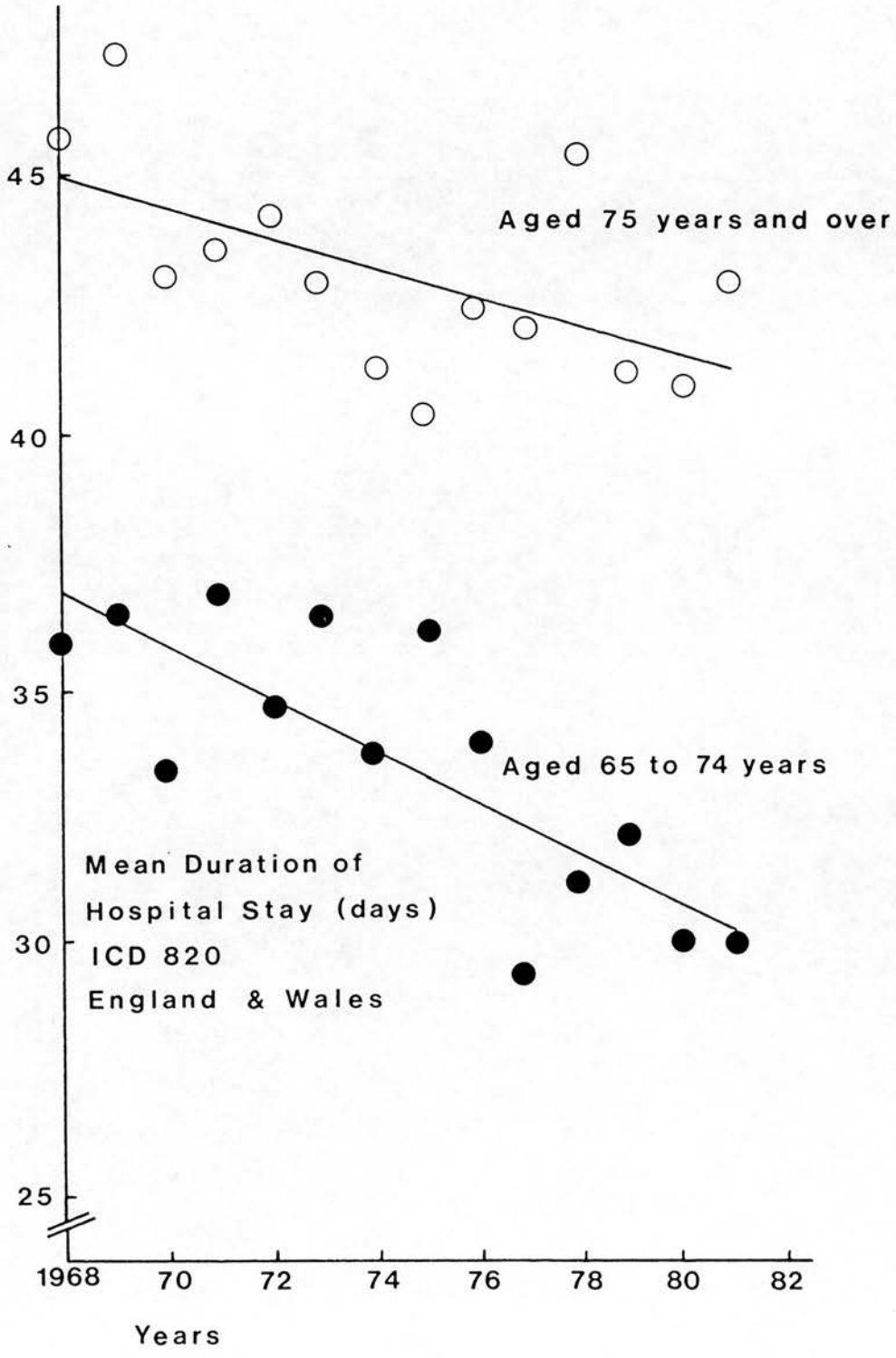

25
20
15
10
5
0
Aged 75 years and over
Hospital Fatality Ratio (per cent)
England and Wales
ICD 820
Aged 65 to 74 years
1968
70
72
74
76
78
82
84
Years

FIG 15


45
40
35
30
25
Aged 75 years and over
Aged 65 to 74 years
Mean Duration of
Hospital Stay (days)
ICD 820
England & Wales
1968
70
72
74
76
78
80
82
Years

5.3 THE ASSESSMENT OF THE ACCURACY OF THE HOSPITAL ACTIVITY ANALYSIS STATISTICS IN STOCKPORT.

Table 38 summarises the results of this investigation.

Of the 325 fracture cases in Stockport residents over the 18 month period, 307 had either died in or been discharged from hospital as at 31 December, 1985. Forty-three fracture cases (14%) were missing from the HAA file. The file contained 322 cases with a diagnosis of femoral neck fracture, aged 25 years and older, who had been admitted to hospital between 1 March, 1984 and 31 August, 1985. Five per cent (17/322) were correct entries about patients who were admitted to hospital for further treatment of femoral neck fractures which occurred before the study period. A few cases (9/322) were correct second entries for the same individual who had either been readmitted or transferred between hospitals during the study period. There were 23 erroneous entries (7%).

TABLE 38.

THE ACCURACY OF THE NORTH WESTERN RHA HOSPITAL ACTIVITY ANALYSIS FILE FOR FEMORAL NECK FRACTURES IN STOCKPORT.

NEW FRACTURES CORRECTLY ON FILE	264
FRACTURES CORRECTLY ON FILE BUT NOT ELIGIBLE FOR INCLUSION (ISOLATED TROCHANTERIC OR SUB-TROCHANTERIC)	9
CORRECTLY ON FILE, BUT READMISSIONS FOR TREATMENT OF EARLIER FRACTURES.	17
PATIENTS READMITTED OR TRANSFERRED DURING THE PERIOD OF STUDY AND THUS RE-ENTERED.	9
ERRONEOUS DUPLICATE ENTRIES.	11
ERRONEOUS - RECORDS COULD NOT BE TRACED.	4
ERRONEOUS - SHAFT FRACTURES INCORRECTLY CODED.	3
ERRONEOUS - INCORRECT ADDRESS CODES.	5
TOTAL NUMBER OF ENTRIES FOR ICD 820 IN STOCKPORT RESIDENTS AGED 25 YEARS + ADMITTED BETWEEN 1 MARCH, 1984 AND 31 MAY, 1985 (INCLUSIVE).	322

A FURTHER 43 FRACTURES (OUT OF 307/325 PATIENTS KNOWN TO HAVE DIED IN HOSPITAL OR DISCHARGED AT 31 DECEMBER, 1985) WERE MISSING FROM THE FILE.

Chapter 6

DISCUSSION.

This study was initiated by the author because of an interest in the evaluation of health care and in particular the problems of caring for the increasing numbers of very old people with multiple health problems. Because resources were limited it was felt that an intervention study was not feasible and it was therefore decided to embark upon an observational study. A 1 year cohort of Stockport residents aged 25 years and over who had sustained a proximal femoral fracture was followed prospectively. An attempt was made to assess the outcome, both in terms of morbidity and mortality, at 6 months (182 days) following the fracture in relation to the supposed objectives of treatment and to make a crude estimate of the resources consumed in providing health care. Because Stockport is in no sense an isolated community but instead is part of a metropolis, a pilot study was conducted for 6 months in order to ensure that it would be possible to ascertain cross-boundary flow of patients into other health districts. The completeness of ascertainment will be discussed below but it was felt that it was reasonable to include the cases of the pilot study in the estimation of incidence rates. The study design was intended to eliminate selection bias and to allow a judgement on outcome at a fixed time interval following the fracture. Therefore, at least in theory, this design allowed for the possibility of empirical generalisation and comparison with other studies.

However, before embarking upon such generalisations and comparisons, it is necessary to consider whether the methodology was sound and whether the Stockport population is sufficiently typical to justify general conclusions about the problem of proximal femoral fractures in elderly people.

THE DEFINITION OF PROXIMAL FEMORAL FRACTURES.

The definition of proximal femoral fracture used in this study was not the same as that implied in the International Classification of Diseases (9th revision) code 820 (`femoral neck fractures´). The present study excluded sub-trochanteric fractures and isolated fractures of the femoral head or trochanters. However the fractures which were excluded comprise only a small proportion of all femoral neck fractures. Some authors have excluded `pathological´ fractures, i.e., fractures occurring spontaneously without any obvious trauma at the site of an obvious pathological lesion (see, for example, [2]). Many authors consider that proximal femoral fractures are due to `involutional osteoporosis´, a term which implies a pathological abnormality. Some `osteoporotic´ fractures can occur spontaneously, while other spontaneous fractures occur because of a definite pathological lesion such as a secondary malignant deposit. For the purposes of the present study it was felt that `pathological´ fractures could not be clearly distinguished from other fractures and thus no attempt was made to exclude them. The definition of proximal femoral fracture used in the present study was a pragmatic definition designed to include those age-associated proximal femoral fractures which cause serious disability because they impair weight bearing.

THE ASCERTAINMENT OF CASES.

In addition to considering the definition of proximal femoral fracture which was used in the study, it is also necessary to consider the completeness of ascertainment of cases in the population at risk. In the prospective cohort study every effort was made to ensure that all proximal femoral fractures occurring in the defined population during the study period were ascertained. Stockport is a health district in a metropolis and it is obviously the case that some Stockport residents will sustain a proximal femoral fracture and be treated outside the district. It was to identify such cases that all hospitals in adjacent health districts with an acute orthopaedic service were visited regularly. It was confirmed that only two male patients, residents of Stockport and less than 50 years old, were treated for acute proximal femoral fracture at the Alexandra Hospital, the only private acute hospital in the Stockport locality, during the study period. Further information was not obtained for these patients and they were excluded from the study. Information was obtained about all other cases occurring in adjacent hospitals.

Cases occurring in more remote districts within the region were identified from the North Western Regional Health Authority's Hospital Activity Analysis computerised records. A few cases occurred in health districts outside the region and these were transferred to Stockport Infirmary during convalescence. An examination of the distribution of the identified cases between the different electoral wards within the borough showed no evidence of systematic under-representation of cases in those wards on the

boundary of the borough suggesting that there was no undetected cross-boundary flow of cases. Proximal femoral fractures usually cause immediate pain and disability and require medical attention. The clinical diagnosis is usually confirmed radiologically. There are no domiciliary radiological examinations in Stockport. The reports of all radiological examinations in Stockport hospitals of the pelvis and hips were scrutinised as a check on the ascertainment of cases from clinical records. For all these reasons it is felt that the ascertainment of cases was as complete as possible.

THE RELIABILITY AND VALIDITY OF THE DATA.

Another important methodological consideration is the reliability of the data collected in the study. The study design required that the patients be followed up at 6 months following the fracture, and since the median age of the patients was 79 years, this imposed constraints on the assessment of outcome. It was felt that it would not be desirable or feasible to review all the elderly people in the out-patient clinic. This meant that it was not possible to make the complete assessment including physical and radiological examinations which might be expected in the usual orthopaedic follow-up clinic. Despite the fact that patients had originally given consent to the follow-up visit, many had completely forgotten about the study and this created some difficulties. These would have been compounded had any attempt been made at a complete physical examination. More sophisticated assessments of hip function have been proposed which attempt to overcome some of the problems in evaluating the subjective aspects of outcome [130] [131]. These would have been difficult to use in the domiciliary

assessment of outcome in the present study because of the need to examine the range of movement of the joint on clinical examination. In any case it had been decided that the more relevant measures of outcome in elderly people were the somewhat subjective and social assessments of functional capability. One advantage of the methodology was that the patients were seen in their place of residence following the fracture and so it was possible to make a better judgement about everyday functional capability in the environment in which the patient was living.

The data relating to variables just before or at the time of the fracture were collected as soon as possible after admission to hospital and in nearly all cases before surgical treatment. The interview with the patient could take from between 10 to 30 minutes depending upon the patient's mental state and ability to communicate. Deafness was a not uncommon difficulty which was aggravated by the lack of privacy in an acute orthopaedic ward and the fact that patients had often come into hospital as emergencies having left their hearing aids at home. The interviews had to be conducted in the typical hurly-burly of a busy, acute orthopaedic ward between the regular routines of nursing care, meal times, visiting times and medical ward rounds. Where the patient's mental test score indicated mental confusion the information was obtained from the person(s) who had provided personal care before admission. On 8 of the 365 days during the year, when the author was unavoidably away, the interviews were conducted by 1 of 3 specially trained medical students. The rest of the interviews, and all the follow-up visits were conducted by the author. The time interval between the fracture and the follow-up visit was decided arbitrarily. It was felt that by 6 months following the fracture the outcome of treatment was largely determined since little improvement in functional capability could be expected beyond this

time. The data relating to the explanatory variables were collected at the time of admission and outcome at this time was unknown. There was, therefore, no possibility that the assessment of the explanatory variables was influenced by knowledge of subsequent outcome. With such a dramatic health care crisis and obviously invasive treatment there was no way in which either the subject or the observer could be `blinded´ with respect to the problem and the intervention.

It is obvious from the above that although every effort was made to be objective and consistent most of the data which were collected were inevitably the somewhat subjective assessments of a single observer who was not trained in orthopaedic surgery.

No formal attempt was made either to assess `quality of care´ or to account for all the costs of health care during the 6 months following the fracture. It is also necessary to recognise that the study did not examine different treatment or programme alternatives. The assessment of effectiveness was not based upon a well designed intervention study but on one type of observational study, the prospective cohort study. All of these design limitations were due to lack of resources and have implications for the cogency of the evidence which is presented. It is estimated that the study occupied about 4,000 hours of the author´s time over a period of approximately 3 years.

Because of the above constraints and limitations it is concluded that there was the possibility of both observer and subject bias but no selection bias. Because data were obtained on well over 90 per cent of subjects for nearly all explanatory variables and follow-up information was obtained on all but 3 subjects it is concluded that there was no appreciable `response´ bias.

THE CARE OF PROXIMAL FEMORAL FRACTURES IN STOCKPORT.

Having considered the strengths and weaknesses of the study design and methodology it is now necessary to consider whether the Stockport population is sufficiently typical to make it possible to draw conclusions about the general problem of proximal femoral fractures in elderly people. Evidence has already been presented which suggests that the Stockport population is, on average, younger and of higher social class than the general population of England and Wales. Since there is a strong association between age and the incidence of proximal femoral fractures it is likely that the crude annual incidence rate is lower in Stockport than in England and Wales. Stockport does however have a larger population than that of a typical health district (250,000) and this means that the total number of proximal femoral fractures in 1 year is likely to be slightly greater than average. There is no evidence that the incidence of proximal femoral fractures varies with socio-economic status. In any case, the conventional method of classifying the latter according to most recent occupation becomes rather more irrelevant in those oldest people who have retired from full-time employment many years previously.

It is possible to compare the Stockport experience with that of other studies with reference to several different aspects of the health care problem including: frequency of proximal femoral fractures in the population, the health care resources (inputs) consumed, the quality of the health care process, and the health outcomes of the associated interventions. Such comparisons should allow some kind of judgement to be made about the applicability of the findings in Stockport to the general problem of proximal femoral

fractures.

There have been several studies of the incidence of proximal femoral fractures in different populations at different times and these have been reviewed elsewhere by the author [3]. The study which provides the best basis for comparison in an attempt to determine how typical Stockport is in terms of the incidence of proximal femoral fractures is that of Boyce and Vessey [132]. These authors estimated the incidence of proximal femoral fractures in Oxford over a period of 1 year starting in 1983. They compared these data, which had been collected prospectively, with data from an earlier study in Oxford from 1954 to 1958 [133]. There was a significant increase in the age specific incidence rates between the two time periods. The estimates of age specific incidence rates obtained in the present study are higher than the estimates for Oxford in the earlier period and lower than those for the later period. There is in fact no statistically significant difference between the Stockport estimates of age specific incidence and those for either period in Oxford. The Stockport and Oxford studies were more or less contemporaneous and there ought, therefore, to have been no confounding by secular changes in incidence. It is therefore concluded that the estimates which have been obtained in the present study of the age specific incidence of proximal femoral fractures in Stockport are not atypical.

It is somewhat more difficult to judge the health care process and the quality of hospital care for patients with proximal femoral fractures in Stockport as compared with other health districts. Certain comments can be made about the services provided: the trauma and acute orthopaedic services in Stockport are not located on the site of the district general hospital; at the time of the study there was no routine multi-disciplinary assessment of elderly patients before operation; most of the operations were performed by

the junior orthopaedic staff and there were perceived shortages in the provision of physiotherapy and occupational therapy services in the acute hospital although there was a combined orthopaedic and geriatric rehabilitation ward for female patients at a nearby hospital. The health professionals involved felt that the acute orthopaedic service could have been improved had more resources been available. Scarcity of resources is a problem which is not, however, confined to Stockport. On average, at any one time some 17 per cent of the acute orthopaedic beds were occupied by patients with proximal femoral fractures. There can be little doubt that the hospital care of patients with proximal femoral fractures in Stockport consumes significant amounts of resources. The mean duration of hospital stay, limited to the first 6 months following the fracture, was surprisingly high at about 59 days. On average, 31 of these were spent in the most expensive acute beds.

Some comparative data about hospital activity in all the health districts within the National Health Service in England have recently become available in the form of `performance indicators´ [134]. These provide some information about the duration of hospital stay for femoral neck fractures (ICD 820) and the provision of residential home places in the community.

Data for 4 of the performance indicators for 1984 were examined.

Performance indicator E19, `length of stay - femur fracture´, is obtained from regional hospital activity analysis (HAA) data and is the average number of days an in-patient case aged 75 years or over occupied a bed following admission for proximal femoral fracture, before being discharged alive. Those cases in whom death occurred in hospital are excluded.

Performance indicator E1A, `institutional care rate - hospital', is obtained from regional HAA and from mental health enquiry data and uses the Office of Population, Censuses and Surveys' (OPCS) mid year estimates of population. It is the annual number of in-patients aged 75 years or over who were discharged from, or died in, hospitals in the district health authority after a duration of hospital stay exceeding 6 months, expressed as a percentage of the district's total resident population aged 75 years and over.

Performance indicator E1B, `institutional care rate - community', uses local authority data and is the annual number of local authority residents aged 75 years and over who occupied a permanent place in a local authority, voluntary or private residential home for elderly and disabled people, expressed as a percentage of the authority's total resident population aged 75 years and over.

Performance indicator E8, `available geriatric beds per 1,000 population aged 75+ years', is based on hospital management information and OPCS mid year estimates. It is the average daily number of available beds in geriatric medicine in the District Health Authority related to the authority's resident population aged 75 years and over in thousands.

Table 39 summarises data for these performance indicators for Stockport and for England. The absolute value for each indicator for 1984 is provided together with Stockport's percentile rank relative to all districts in England. It can be seen that Stockport is close to the median value for 3 indicators: E19, E1A, and E1B. The value for Stockport for indicator E8 is on the 87th centile suggesting that Stockport has a higher than average provision of geriatric hospital beds.

TABLE 39 - COMPARISON BETWEEN STOCKPORT AND ENGLAND FOR SELECTED PERFORMANCE INDICATORS.

PERFORMANCE INDICATOR. (see text)	ABSOLUTE VALUE STOCKPORT.	ENGLAND.	PERCENTILE RANK FOR STOCKPORT.
E19 Length of stay - femur fracture.	37 DAYS	34 DAYS	57
E1A Institutional care rate, hospital.	5.7%	5.9%	48
E1B Institutional care rate, community.	5.2%	5.4%	57
E8 Geriatric beds/ 1,000 population aged 75+ years.	25.5/1,000	18.6/1,000	87

It is not surprising that the absolute value for indicator E19, 37 days, is different from the figure of 59.1 days for the mean duration of hospital stay in the first 6 months following a proximal femoral fracture which was obtained in the present study since the two values have been calculated in different ways. HAA data usually relate to `episodes´ rather than to individuals. Thus the same individual admitted several times for the same condition would count as several episodes. The estimate in the present study included, for each individual, any hospital stay during the first 6 months following a fracture. For proximal femoral fractures, since the first admission is usually an emergency admission for surgical

treatment at a time of crisis, it is likely that first admissions will tend to be of longer duration than subsequent planned admissions for further treatment. Furthermore, performance indicator E19 excludes deaths in hospital and persons aged under 75 years. This would in fact tend to increase the estimate of mean duration of hospital stay since analysis of national HIPE data in the present study has shown that the mean duration of hospital stay for patients aged 75 years or over is higher than for patients aged 65 to 74 years. The main reason for the difference between the two estimates must relate to the fact that the analysis of HAA data used in estimating the performance indicator will not identify episodes for further treatment of the same problem in the same individual.

HAA data are more likely to be subject to errors of coding and standards of accuracy may vary between different regions. Rees has suggested that apparent variations in estimates of incidence based on HAA data can be explained by variations in the accuracy of coding [135]. During scrutiny of the North Western Regional Health Authority's HAA data in the present study, it was noted that, for some hospitals, inter-hospital transfers during the same treatment episode were counted twice, while in others such a transfer did not generate an additional event. Despite possible variations in the accuracy of diagnostic coding of HAA data, performance indicators are useful in making general comparisons of activity in different health districts.

Comparison of the performance indicators for Stockport and England and Wales would suggest that Stockport is not markedly different from other health districts in the duration of hospital stay for proximal femoral fractures, or in the general provision of hospital and residential care for elderly people.

There have been relatively few studies of the outcome of hospital treatment for proximal femoral fractures in defined populations followed prospectively for a finite period after the fracture. The study which is most directly comparable with the present study is that of Evans et al [6]. These authors also conducted a prospective cohort study over a period of 1 year of patients with proximal femoral fracture. The study included 211 patients aged 65 years or over who were residents of Newcastle Metropolitan District. The estimated case fatality proportion at 6 months following the fracture was 40.3 per cent (95% confidence limits: 33 to 47 per cent) compared with 29.6 per cent (95% confidence limits: 23.8 to 35.4 per cent) in the present study. Although these estimates are not significantly different, 10.5 per cent of the patients included in the present study were aged 25 to 64 years and these younger patients have a lower case fatality. This probably explains the lower estimates obtained in the present study. Other estimates of the case fatality proportion in population based series of proximal femoral fractures have been 19 per cent at 6 months [2] and 36.2 per cent at 12 months following the fracture [136].

In the Newcastle study, 82 per cent of the patients had surgical primary treatment compared with 90 per cent in the present study, and the mean durations of hospital stay in the two series were identical at 59 days.

The data presented would suggest that it is reasonable to conclude that the experience of elderly patients sustaining proximal femoral fractures in Stockport is not atypical.

If it is accepted that the methodology of the present study is sufficiently robust, and that Stockport is not so different from

other health districts, it becomes possible to generalise from this particular health district to the general problem of proximal femoral fractures in elderly people.

THE EFFICIENCY OF CARE.

The examination of trends in England and Wales in routine mortality and hospital morbidity statistics would tend to suggest that the efficiency of hospital care for proximal femoral fractures has improved between 1968 and 1981. In other words for a given input of health care, in this case treatment in hospital, the health outcome is now better. Overall, the standardised death rates for femoral neck fractures in people aged 65 years and older have improved. For people aged 65 to 74 years the inputs, as measured by mean durations of hospital stay, have decreased while the outcomes, measured by hospital fatality ratios, have remained unchanged. For people aged 75 years or over the inputs have decreased and the hospital fatality ratios have improved.

There are, however, several problems in interpreting these data. Mortality rates are a function of both incidence and case fatality. They are also influenced by changes in certification practices although there is no reason to suppose that these have changed for femoral neck fractures during the period in question. The eighth revision of the International Classification of Diseases was introduced in 1968 and the ninth in 1979 and the code for femoral neck fractures has remained unchanged throughout. However, in only about one half of the patients in the present, prospective, cohort study who were dead at 6 months following the fracture was the diagnosis of femoral neck fracture mentioned on the death

certificate. It is likely that, in most of the patients who died, the major event of a proximal femoral fracture occurring within the preceding 6 months would have contributed to the death. This would suggest the need for extreme caution in interpreting cause specific mortality rates since not all deaths which might be attributed to proximal femoral fractures are certified as such.

Hospital In-patient Enquiry statistics, which are based on a sample of all admissions to hospital of approximately 10 per cent, also need to be interpreted with care since changes in patterns of referral to hospital might influence hospital fatality ratios independently of changes in treatment. Since femoral neck fractures are almost always immediately disabling and are usually treated in hospital, hospital statistics probably represent most cases and there is no reason to suppose that referral practices have changed in the last 20 years. The analysis of the accuracy of the Hospital Activity Analysis data, which form the sampling frame for the Hospital In-patient Enquiry statistics, suggests that in Stockport there are errors in significant proportions of patients which need to be considered in interpreting hospital morbidity data. Rees has shown that there are differences for femoral neck fractures in the ratio of erroneous entries between different districts in a single health region [135]. These variable and unknown error rates complicate attempts to interpret the routine data. The statistics relate to hospital admissions or events rather than to individuals so that a proportion of the admissions will be re-admissions for the treatment of the late consequences of fractures; thus the fatality ratio does not represent operative mortality. Since the proportion of patients surviving after a fracture decreases with time, the fatality ratio will be influenced by changes in durations of stay in hospital. For this reason, it is less satisfactory as a measure of the outcome of treatment than the case fatality proportion at a

defined point of time after the fracture. It has been suggested that the age specific incidence rates for femoral neck fractures are increasing [132]. This would suggest that the declining mortality rates are due to a reduction in the case fatality rate. This is consistent with the observed reduction in the hospital fatality ratio for people aged over 75 years and is probably due to earlier mobilisation post-operatively and to improved anaesthesia. In other words, the efficiency is improving because of the improved effectiveness of hospital treatment.

Despite this somewhat problematic evidence that the overall efficiency of hospital care for proximal femoral fractures in England and Wales has improved in recent years, the findings from the present prospective cohort study in Stockport would suggest that the efficiency of hospital care is still far from satisfactory. The median age of the patients at the time of the fracture was 79 years indicating that the patients in general were very old. The primary treatment of the fracture was surgical in 90 per cent of the cases and the mean duration of hospital stay in the 6 months following the fracture was 59 days. A crude assessment based on the average cost of hospital stay per in-patient day would suggest that the 237 fracture cases consumed a considerable amount of the District´s annual revenue. In 30 per cent of the fracture cases, the patient was dead by 6 months following the fracture, and an additional 9 per cent were still in hospital. These facts, together with the data presented about morbidity at 6 months following the fracture, would suggest that it is still reasonable to think of at least some proximal femoral fractures as `unsolved fractures´ [14].

The comparison between the survival curves of the fracture patients and the general Stockport population in the 3 age-groups: 65 to 74 years, 75 to 84 years, and 85 years and over, suggests that the survival disadvantage experienced by fracture patients increases

with age. This comparison is not, however, entirely valid since in the method used those patients who had experienced a proximal femoral fracture were included in the general population life tables. Since they are only a minority in the general population such comparison does, nevertheless, give an indication of the relatively poor survival experience of fracture patients. The excess mortality associated with fractures may be partly explained by the fact that about three quarters of the fracture patients had active medical problems at the time of the fracture.

THE QUALITY OF CARE.

Although, as has already been indicated, no formal attempt was made to assess `quality of care´, it is still possible to make a subjective, and therefore tentative, evaluation of this aspect of hospital care for proximal femoral fractures. Despite evidence that the patients not infrequently have other health and social problems, proximal femoral fractures still tend to be seen as an orthopaedic problem. The fact that the patients may have multiple health and social problems would imply the need for an active, multi-disciplinary team approach to their care. In fact, because of geographical dispersion of health care and perceived resource constraints, such multi-disciplinary cooperation was inhibited in Stockport. At the time of the study, the geriatricians felt unable to provide a routine input into the work of the acute orthopaedic unit, although they were always ready to advise on specific problems when requested. There was no occupational therapist at Stockport Infirmary who was able to give undivided attention to the needs for rehabilitation of elderly patients following surgical treatment of proximal femoral fractures. The occupational therapist visited the infirmary as and when requested but it could be argued that a continuous service would have been preferable.

In an attempt to avoid the complications of recumbency, every effort was made to operate on those elderly patients deemed suitable for primary surgical treatment as soon as possible after admission to hospital and to mobilise the patients as soon as possible after operation. Sometimes it was necessary to correct remediable problems such as mild cardiac failure or pre-operative anaemia

before surgery. There were occasional difficulties in obtaining speedy advice from physicians and anaesthetists and surgical treatment was sometimes delayed for this reason.

It is obvious that the primary surgical treatment was only the first stage in a long term process of recovery and rehabilitation following a proximal femoral fracture. The median duration of hospital stay in the 6 months following the fracture as observed in the prospective cohort study was 30 days. Approximately 17 per cent of acute orthopaedic beds were occupied by patients who had sustained proximal femoral fractures at any one time. There is a danger that such patients might be seen as blocking acute orthopaedic beds. For example, in a point prevalence survey of patients occupying acute orthopaedic beds in Bromley in June, 1983, Coid and Crome found that 9 per cent of patients could be classified as `bed blockers´, i.e. patients who had occupied the acute bed for at least 31 days and who no longer required the facilities provided therein [137]. It is likely that most of these patients were recovering from proximal femoral fractures. There can also be problems in attempting to communicate with the patients because of confusion and sensory impairments. Elderly people may take longer to recover from the effects of a surgical operation than young, fit adults and tend to require much more heavy nursing care.

For all these reasons, hospital treatment for proximal femoral fractures can make particular demands on nursing and medical staff. Such demands are not always recognised: for example, nurses working on geriatric wards may be eligible for an income supplement because of the heavy nursing workload but this supplement was not available to the nurses dealing with a similarly heavy workload on the acute orthopaedic ward. The prolonged hospital stay would tend to suggest that `care´ is as important a component of hospital treatment as attempts at `cure´. When there are several elderly patients on an

acute orthopaedic ward it is perhaps not surprising that there may be a tendency for the `batch processing´, ritualisation and scheduling of care which have been described in institutional care in other contexts [138].

It might be thought that one way of avoiding some of these problems on the acute orthopaedic wards would be to move the patients to a rehabilitation ward once they have recovered from surgery. Only 28 per cent of female patients in Stockport were transferred to such a ward for rehabilitation. The patients often had to stay on the acute orthopaedic ward when they no longer had an acute medical or surgical problem because of the difficulty of finding a suitable placement. Robbins and Donaldson presented data which suggested that this problem was not unique to Stockport [139]. They found, in a prospective survey of all 216 patients with fractured neck of femur presenting over a 20 week period to the acute orthopaedic service in Leicestershire, that patients awaiting discharge after the completion of medical and surgical treatment accounted for 28 per cent of the total patient-days in hospital.

In making these tentative comments about the `quality of care´ of hospital treatment for proximal femoral fractures in Stockport, the author is in no way intending to criticise the health professionals involved in caring for patients with this difficult health care problem. Because of demographic changes the acute orthopaedic service is having to cope with increasing numbers of elderly people with acute proximal femoral fractures at a time when resources are becoming increasingly scarce. A review of the orthopaedic literature of recent years would suggest that proximal femoral fractures have tended to be seen largely as a technical problem.

The findings of the present study suggest that these fractures present a much more complex problem of caring at a time of crisis for elderly people with multiple health and social problems. They precipitate a crisis which threatens both the autonomy and the life of elderly people. The fracture can be thought of as one more incident in the gradual decline in functional capability which characterises extreme old age. The elderly person with a proximal femoral fracture is particularly vulnerable to such life threatening conditions as broncho-pneumonia, cardiac failure and pulmonary thrombo-embolism as was demonstrated by the causes of death in the present study. In such a situation it can be particularly difficult to agree the objectives of health care, to predict outcome and to involve the elderly person in decisions about treatment. In this context, it is worth stressing that about 10 per cent of the elderly people in the present study were unable to answer any of the questions in the test of mental function at the time of admission to hospital. Most of these patients had had a long history of symptoms of dementia and clearly were not competent to make a decision about treatment. Many other patients showed evidence of milder degrees of confusion. It sometimes seemed as though the fracture was a convenient excuse for passing the problem on to the acute orthopaedic service rather than attempting to assess the individual needs of the patient and decide on the appropriateness of the surgical or technical approach to treatment.

FUTURE STRATEGIES FOR PROXIMAL FEMORAL FRACTURES.

It has been suggested that further improvements in the efficiency and quality of the hospital care for proximal femoral fractures are desirable. It is also obvious that, because of demographic changes, these fractures are likely to consume an increasing proportion of health service revenue at a time of resource scarcity. It is, therefore, necessary at least to consider future health care strategies for dealing with this problem. One such strategy might be to attempt to prevent the fractures from occurring in the first place. The author has argued elsewhere that the prospects for prevention are not promising [3].

One preventive approach that has been suggested is hormone replacement therapy at the time of the menopause in women in an attempt to retard involutional osteoporosis. The evidence that this approach might be successful comes from retrospective case-control studies of the association between peri-menopausal hormone replacement and proximal femoral fractures. However, it is necessary to be extremely careful in interpreting the results of such studies [140]. With this study design it is impossible to be certain that the two groups (cases and matched controls) are similar with respect to all other relevant variables apart from hormone exposure. The only direct evidence for a protective effect of hormone replacement therapy on proximal femoral fractures would come from prospective randomised case-control studies over a period of several decades. The formidable methodological problems with such a design are obvious and explain why no such evidence is yet forthcoming. Because proximal femoral fractures only afflict a minority even of very old people, it would be necessary to recruit

enormous numbers of subjects for such trials.

Another preventive strategy that has been suggested is to attempt to minimise the chances of elderly people sustaining falls. While it is true that most proximal femoral fractures are associated with falls (94 per cent in the present prospective cohort study), community studies of falls in elderly people suggest that only a minority of falls result in proximal femoral fractures. These studies also suggest that with increasing age, factors intrinsic to the subject who falls such as, for example, impaired postural control are more important in the aetiology of such falls than extrinsic environmental factors such as loose carpets or electrical cables [141]. The susceptibility to falling can almost be regarded as an inevitable consequence of growing old. Evidence from the present study suggests that most fractures occur during hours of normal activity. It is likely that massive efforts would be necessary to prevent significant numbers of falls due to extrinsic environmental factors. Even if such a strategy were successful, since proximal femoral fractures only occur in association with a minority of falls, it is likely that most proximal femoral fractures could not be prevented in this way.

Perhaps the best prospects for preventing proximal femoral fractures might be generally to improve the health of elderly people through initiatives in health promotion earlier in life. Factors such as regular exercise, balanced nutrition and the avoidance of cigarette smoking are likely to have a beneficial effect in later life although there is no firm evidence that such changes in individual behaviour and life style will prevent age associated fractures.

If the prospects for preventing proximal femoral fractures are not encouraging, it is necessary to try and improve the

cost-effectiveness of hospital treatment. A major difficulty with this approach is that the treatment of these fractures evolved before the need for randomised controlled clinical trials of treatment became widely accepted. There have been countless published series of cases of proximal femoral fractures treated in different centres with different devices by orthopaedic surgeons with varying degrees of interest and expertise in the problem. It is very difficult to compare the results of these different series for reasons already mentioned: the series tend to be based on undefined populations so it is not possible to know whether there had been any selection of cases, and the patients were followed up for varying time intervals following the fracture. Another difficulty is that many of the studies have tended to concentrate on more technical measures of outcome such as the frequency of non-union or late superior, segmental collapse of the femoral head, rather than on measures which are more directly relevant to the patients' functional capability such as scores for the activities of daily living. The importance of considering more social aspects of outcome was stressed by Thomas and Stevens [142].

There have been very few randomised controlled clinical trials of different primary surgical treatments for proximal femoral fractures. Soreide et al reported on the results of a randomised controlled trial of internal fixation with von Bahr screws versus hemi-arthroplasty with a Christiansen trunnion-bearing prosthesis in the primary treatment of acute displaced intra-capsular fractures [143]. One hundred and four patients aged 67 years or over were allocated at random into the 2 treatment groups. These groups were otherwise comparable with respect to age and sex distribution and the frequency of concomitant diseases. The mean age of the patients at the time of surgery was about 78 years. They were recruited into the trial over a period of 2 years.

Compared with internal fixation, the mean operation time and duration of hospital stay were significantly longer for patients treated by hemi-arthroplasty (Christiansen prosthesis). There were also significantly more early post-operative complications in this group but there was no significant difference in mortality. By 1 year following the fracture, the internal fixation group had a greater frequency of complications and were more likely to need a second operation, although these differences did not quite reach statistical significance ($P = 0.06$). An attempt was made to cost the two treatments and it was estimated that hemi-arthroplasty was about 1.6 times as expensive as screw fixation (14,360 krone compared with 8,940 krone, 1976 prices) [144].

Sikorski and Barrington reported on a randomised controlled trial of internal fixation with Garden screws versus either anterior or posterior hemi-arthroplasty using a Thompson prosthesis. The trial included 218 patients aged 70 years or over with displaced sub-capital fractures [145]. The study was performed in Bristol and the patients were recruited to the trial over a period of 3 years. In formulating the objectives of this study, the authors had noted that in a proportion of patients following internal fixation a further operation (usually hemi-arthroplasty) was necessary because of a failure of bony union. They therefore wondered if primary arthroplasty was preferable in the treatment of displaced sub-capital fractures. The mean age of the patients was 80 years.

The trial design allowed for the possibility that in some patients randomly allocated to internal fixation it would not be possible to obtain a satisfactory reduction of the fracture, in which case hemi-arthroplasty was performed. The patients were followed up for 2 years after treatment and the authors assessed pain and mobility using simple ordinal scales. They also assessed

the technical adequacy of the surgical treatment on the basis of the first post-operative radiograph. The surgical operations were carried out by orthopaedic trainees of variable degrees of experience. The authors concluded that anterior Thompson hemi-arthroplasty was followed by significantly lower mortality from 6 months following the fracture and by a lower incidence of systemic complications but by a higher incidence of wound infections. In the 3 treatment groups and in the patients with irreducible fractures, there was a high frequency of technical failures (varying from 33 per cent for posterior Thompson hemi-arthroplasty to 46 per cent in the group treated by internal fixation). In all groups, overall walking ability at the time of follow-up was worse than before the fracture, the greatest deterioration being after anterior Thompson hemi-arthroplasty.

Nordkild et al have recently reported on a randomised controlled trial which compared two different types of internal fixation with either a sliding nail plate or a sliding screw plate [146]. The patients were either aged less than 70 years or were said to have a high level of physical activity. There were only 49 patients in this trial and there were differences in the age distribution of the patients between the two groups. Perhaps because of the small numbers of patients in the trial, the only statistically significant differences between the 2 groups were that patients treated with sliding screw fixation were less likely to develop a varus deformity and were less likely to suffer post-operative pain, although the assessment of the latter was inevitably subjective.

Sonne-Holm et al reported the results of a randomised controlled trial of patients aged over 70 years with acute femoral fractures of unspecified type [147]. The patients were randomly allocated into two groups which were treated by Moore

hemi-arthroplasty with and without bone cement. One hundred and twelve patients were entered in the trial and they were assessed at 6 weeks, 3 months, 6 months and 12 months post-operatively for pain, hip mobility and gait using simple ordinal scales. The clinical assessor was unaware of the type of treatment. The authors do not give sufficient details about the patients to be sure that both treatment groups were otherwise comparable but they claimed that, at least during the first 6 months following the operation, the patients treated with a cemented prosthesis had a more normal gait and complained of less pain.

A few randomised controlled trials have examined aspects of the care of patients with proximal femoral fracture other than primary surgical treatment. For example, Bastow et al reported the results of a randomised controlled trial which examined the effect of overnight supplementary naso-gastric tube feeding [148]. One hundred and twenty-two poorly nourished patients were randomly allocated into intervention and control groups. The two groups were otherwise comparable in terms of fracture type, type of treatment and the frequency of associated diseases. The rationale for this trial was an earlier observation that approximately one fifth of elderly women admitted to hospital following a proximal femoral fracture appeared to be undernourished and that these patients had a higher mortality [149].

Approximately one fifth of the patients in the intervention group were unable to tolerate the naso-gastric tube. Nevertheless, the patients in the intervention group showed a statistically significant reduction in the time taken to become independently mobile following operation and in the duration of hospital stay in the most undernourished women. The women in the intervention group also showed significantly greater improvements in indices of nutritional status such as mid arm circumference and triceps

skinfold thickness.

This brief summary of the few randomised controlled trials of specific interventions designed to improve the treatment of patients with proximal femoral fracture, together with the findings of the present study, can be used to illustrate some of the difficulties involved in attempts to improve the cost-effectiveness, quality and efficiency of treatment for proximal femoral fractures. These difficulties broadly fall into 3 groups: resource constraints, ethical problems and problems with methodology. Resource constraints and the cost of studies of evaluation have already been discussed.

One of the fundamental ethical issues concerns the fact that patients with proximal femoral fractures are very old. The median age at the time of the fracture was 79 years and there was evidence of co-existing health and social problems in a substantial proportion of the patients. It can be difficult to agree about the objectives of treatment in such patients. There would be little disagreement that such objectives should include the alleviation of pain, the restoration of mobility and social function, the avoidance of complications, including death and decubitus ulcers [150], and the provision of humane care. However these objectives can be mutually conflicting: well-intentioned attempts to restore mobility may be followed by prolonged suffering and death.

Orthopaedic surgeons have to live with an inevitable uncertainty about the outcome of treatment in any individual patient. They are in the invidious position of having to achieve a balance between the different objectives of treatment based upon their subjective assessment of the individual needs of the patient.

There is an understandable reluctance to abandon methods of treatment which, although they may not have been subjected to rigorous evaluation in randomised controlled trials, nevertheless have been refined and tested in years of clinical experience. It may be argued that it is not ethical to deny patients the potential benefits of such treatment by random allocation in a clinical trial. It is argued that, because the patients are old and therefore susceptible to the complications of recumbency such as broncho-pneumonia and pulmonary thrombo-embolism, surgical treatment which offers the prospect of immediate fixation of the fracture and early mobilisation is preferable despite the element of uncertainty.

Another problem which complicates attempts to agree the objectives of treatment is caused by ignorance about the `natural history´ of patients with proximal femoral fractures. It is certainly the case that some patients might die needlessly if they were not treated surgically because of the hazards of recumbency in elderly people. However, most fractures are treated surgically and there are no adequate trials which have compared surgical and non-surgical treatment. It is therefore difficult to be sure that surgical treatment is in general superior to conservative treatment for all elderly people.

From the patient´s point of view there are other ethical difficulties. It is generally accepted that randomised controlled trials of treatment should only be conducted on patients who have given their informed consent following full discussion with the doctor involved. About 10 per cent of the patients in the present study could not even give their names on questioning at the time of admission to hospital. Many more showed evidence of disorientation. It is clear that a substantial proportion of patients were not competent to give informed consent to

participation in a trial.

A more subtle ethical issue is that even those who were mentally alert and competent were somewhat disadvantaged at the time of admission to hospital and therefore could not be equal participants in decisions about treatment. From the patient's point of view, proximal femoral fractures cause a sudden and unexpected loss of autonomy. Their choice is between, on the one hand, certain recumbency and possible complications thereof and, on the other hand, a surgical operation which offers the prospect of a quick restoration of mobility and the possibility of post-operative complications. There is a dilemma between the need to make a quick decision so as to avoid possible complications of recumbency and the need to make a considered decision. There clearly are ethical problems with randomised, controlled trials of treatment for proximal femoral fractures which are greater than those usually encountered.

In addition to the ethical problems of attempting to improve treatment through rigorous evaluation, there are formidable methodological difficulties. Patients with proximal femoral fractures do not constitute a homogeneous group even though they may have similar anatomical lesions. They may differ in many obvious ways including age, personality and motivation, socio-economic circumstances, the degree of displacement and stability of the fracture, and the presence of co-existing disease. The implications of this heterogeneity are that the choice of treatment should be based on an assessment of the needs of the individual patient and that several factors which are not directly related to the fracture itself may have an independent effect on outcome.

In the present study, several variables were shown on univariate analysis to be significantly associated with survival

during the 6 months following the fracture. Many of the variables were, however, inter-related and when these joint effects were considered in multivariate analysis 5 variables were found to have an independent association with survival. Cox's proportional hazard model provides a non-parametric multivariate test for the association between the independent variables and survival and it can be used when the survival data are incomplete and singly censored as in this study [120]. The fact that a high blood phosphate level had the most significant association with poor survival was an unexpected and unexplained finding. This variable was originally included in the analysis, together with blood calcium and alkaline phosphatase, as a proxy measure of vitamin D status because of the suggestion that vitamin D deficiency is important in the aetiology of some proximal femoral fractures [151]. In vitamin D deficiency a low calcium-phosphate product would be expected since both blood calcium and phosphate levels are low. In fact there was no independent association between calcium-phosphate product and survival in the present study. There was, therefore, no suggestion that vitamin D deficiency had any effect on outcome. One possible explanation for the observed association is that patients with a high blood phosphate level were suffering from renal impairment and this affected outcome. Unfortunately, no information was obtained in the present study about blood urea and creatinine concentrations which might have supported this suggestion.

The associations between survival and the other 4 significant variables were all plausible. The association between mental impairment and poor survival has been observed in other studies and is not surprising in view of the need for patients to cooperate if rehabilitation is to be successful [142] [152] [153] [154] [155] [156] [157] [158] [159]. Evans et al also observed that patients who fell in a public place had a better prognosis and the explanation

for this is that these patients are generally healthier [155]. The negative association between both age and a history of an active medical problem and survival is also to be expected.

Different variables were associated with the outcome at 6 months in terms of morbidity in survivors. It must be emphasised that the classification of outcome into `success´ and `failure´ on the basis of walking ability was both arbitrary and crude, although necessary for statistical purposes. It was not in any sense intended as a clinical judgement about the outcome of treatment in those patients surviving 6 months. Only 30 per cent of survivors at 6 months were classified as `successes´. Despite the crudeness of the classification, the findings are generally plausible. Those survivors who, at the time of fracture, were regularly driving a car, were able to climb a flight of stairs without assistance, were able to walk unaided, were fully independent and who had surgical treatment soon after admission to hospital, were more likely to have a successful outcome in terms of walking ability at 6 months following the fracture. The model also suggested that there was a significant positive association between both living in Stockport and male sex and the probability of a successful outcome at 6 months in terms of walking ability. These associations are unexplained and would require to be confirmed in other studies before being accepted. The negative sign of the coefficient for the variable Stockport resident does not mean a negative association with a successful outcome since the design variable for living in Stockport is -1.

The results of these statistical analyses of the association between different independent patient characteristics at the time of the fracture and the dependent variable of outcome, expressed either as mortality or morbidity, have implications for randomised controlled trials of different treatments. It follows that if

several different variables have an independent association with outcome, these variables might confound any association between treatment and outcome. The fact that in the analysis of the relationship between the independent variables and survival the univariate analysis suggested several significant associations which were not confirmed by multivariate analysis is due to interaction between the independent variables. Such interactions indicate the need for extreme caution in attempting to make decisions about the likely success of treatment on the basis of a single variable such as age. In order to interpret any controlled trial of treatment, it is necessary to be sure that the intervention and control groups are comparable with respect to all variables which might have an independent effect on outcome. This might be achieved by `matching´ the two groups with respect to known relevant variables but if several variables are involved the permutations become formidable and very large numbers of subjects would be required for the trial to have sufficient `power´ [160]. Random allocation should ensure, in the long run, that the two groups will be comparable with respect to known and unknown potentially confounding variables, but with so many relevant variables large numbers of subjects might still be required to ensure comparability.

Because patients with proximal femoral fractures are a heterogeneous group it follows that the efficiency of treatment might be different in groups of patients with different characteristics. In the present study it was possible to identify a group of patients in whom the chances for survival during the first 6 months following the fracture were poor. This group was identified arbitrarily on the basis of those variables known to have an independent association with outcome. One way of improving the overall cost-effectiveness of treatment might, therefore, be to concentrate on those patients judged to have a high chance of an

unsuccessful outcome. This approach might at least overcome some of the ethical resistance to a randomised controlled trial. However, the problem with this approach is that although multivariate analysis is a useful technique for identifying possible prognostic factors in relatively small numbers of patients, it cannot necessarily be assumed that those variables which were identified in the present series have universal validity. Methodological standards have recently been proposed for clinical prediction rules and it is clear that considerable further work would need to be done before validated rules became available to assist in the management of the difficult clinical problem proximal femoral fractures [161]. It is worth noting that the `poor-risk´ group comprised only 13 per cent of all cases. It is also noteworthy that in the present study neither multivariate analysis suggested that either the type of treatment or the type of the fracture had an independent effect on outcome.

Many other methodological problems with randomised controlled trials of treatment for proximal femoral fractures could be discussed in similar detail but these are beyond the scope of this thesis. One other problem which should be mentioned however is the difficulty of deciding which interventions to test. The range of alternatives might include different metallic implants [13], different ancillary measures designed to improve nutrition [148] or prevent complications such as thrombo-embolism [162], different strategies for treatment, for example active multi-disciplinary assessment and rehabilitation versus routine care [163] or different types of anaesthesia [164]. The sceptic might conclude that the range of alternatives proposed is of itself evidence that the existing treatments are far from satisfactory.

An alternative approach which has been advocated in recent years in an attempt to improve the overall outcome of treatment is a

combined orthopaedic and geriatric approach to care with a particular emphasis on post-operative rehabilitation [165] [166] [167] [168]. This approach was pioneered in Staffordshire, Hastings, Nottingham and Edinburgh and was commended in the Duthie report as a means of reducing the duration of hospital stay following a proximal femoral fracture [166] [169] [170] [171] [5]. The main principles involved in this type of care are now widely accepted and include the early involvement of a geriatrician together with joint responsibility for, and joint decision making about, rehabilitation and subsequent placement on discharge from hospital. From the orthopaedic point of view early post-operative mobilisation is emphasised. It is argued that the skills of the geriatrician in the rehabilitation of elderly people and in multi-disciplinary teamwork with social workers, occupational therapists and physiotherapists can reduce the duration of hospital stay following proximal femoral fractures.

Fordham et al recently reported the results of a randomised controlled trial of the cost-effectiveness of this approach compared with routine orthopaedic care for proximal femoral fractures in Huddersfield [163]. Six rehabilitation beds at a long stay hospital were converted into geriatric orthopaedic beds and a joint management system between orthopaedic surgeons and geriatricians was agreed. The geriatrician did not become involved in joint management with the orthopaedic surgeon until after surgical treatment. One hundred and eight female patients aged 65 years or over were entered into the trial and were allocated at random either into routine orthopaedic care or joint management. It was found that the joint management cost an extra 3.6 per cent per patient and that there were no significant differences either in the duration of hospital stay or in the outcome as assessed in terms of activities of daily living either at discharge from hospital or after 4 weeks

treatment. The extra costs associated with joint management were mainly due to the cost in time and money for the doctors in moving between the district general hospital and the site of the geriatric orthopaedic beds. The authors were careful to point out that even though they had demonstrated that the joint management scheme was apparently less cost-effective on formal assessment, the additional costs were relatively small and could largely be avoided if all facilities were provided on a single hospital site. They did not, therefore, conclude that the joint management approach was not worthwhile.

Sikorski et al have claimed on the basis of a historically controlled non-randomised intervention study that a `rapid transit system´ can reduce the duration of hospital stay and improve outcome in terms of morbidity and mortality [172]. This system involves an early joint assessment by the orthopaedic surgeon, the anaesthetist and the physiotherapist together with an operation under spinal anaesthesia, where appropriate, as soon as possible after admission to hospital and early discharge after an average duration of stay of 3 nights.

The preceding discussion suggests that there are no simple answers to the problem of improving the care of patients with proximal femoral fractures. Recommendations have to be made on the basis of accumulated clinical experience and judgement rather than on the results of more formal evaluative studies. It has been suggested that the evaluation of health care needs to take account of the objectives of treatment and that for surgical treatment in very old people, it can be almost impossible to balance the different objectives of treatment and to take account of the legitimate interests of all parties involved. In the case of proximal femoral fractures such parties include the patient, the health care professionals, the person who would normally provide the

principal personal care of the patient and society in general which has to find the necessary resources. While it is undoubtedly desirable to alleviate the suffering of elderly people with proximal femoral fractures, it is clearly not possible to reverse the gradual decline in social and functional capability which occurs in extreme old age. The present study has suggested that the outcome of current treatment for proximal femoral fractures in those elderly people who are already impaired mentally and incapacitated physically is less than satisfactory. Other studies have confirmed these findings. The randomised controlled trials of treatment which have been reported have not suggested any simple way of improving the situation.

It is unlikely that reliable decision rules for predicting an unsuccessful outcome will become available in the forseeable future. Ninety per cent of the patients in the present study were treated surgically and the results of the multivariate analyses did not suggest that treatment had an independent effect on outcome. The main reasons for not operating were more related to concurrent medical problems than to an assessment of the patient's pre-existing mental and physical state. The unavoidable conclusions from this study must be that proximal femoral fractures are not merely a technical problem and that surgical treatment is not appropriate in all cases. Because an elderly person sustains a proximal femoral fracture towards the end of her natural life, it does not follow that orthopaedic surgeons alone should have to manage the problem regardless of the individual patient's needs and circumstances. In the present study 15 per cent of patients were already sufficiently dependent to be living in a residential home and another 9 per cent sustained their fracture while occupying a hospital bed. A substantial number of patients had evidence of dementia. There is insufficient evidence that attempts at cure through internal

fixation or hemi-arthroplasty provide more efficient or better quality health care in such patients than more simple measures such as analgesia, traction and good nursing care.

RECOMMENDATIONS FOR IMPROVING THE HEALTH CARE FOR PROXIMAL FEMORAL FRACTURES.

Because patients with proximal femoral fractures have complex, multiple problems, previous recommendations for a combined multi-disciplinary team approach are sensible and are supported. Because of the real problems of recumbency in older people, recommendations that patients should be mobilised as soon as possible after operation are also supported for those patients who are reasonably independent physically and mentally competent at the time of the fracture. However, it is suggested that orthopaedic surgeons should feel more able to refuse surgical treatment in those patients who, in their considered clinical judgement, are already so incapacitated physically and mentally that the prospects for reasonable restoration of function are poor.

RECOMMENDATIONS FOR IMPROVING CARE IN STOCKPORT.

In Stockport it will be necessary to ensure that there are sufficient geriatricians to support orthopaedic surgeons in the assessment of patients with proximal femoral fracture at the time of admission to hospital. Such a policy may involve some additional investment in resources but it ought not to be acceptable for

patients with a poor chance of survival to languish for weeks on an acute orthopaedic ward. Care can be provided equally well, and probably more cheaply, elsewhere. In Stockport, as in Huddersfield, there will be problems since the acute orthopaedic and acute geriatric services are on different hospital sites. The long term strategy should be to move the emergency orthopaedic service to Stepping Hill Hospital which is the district general hospital where the acute geriatric service is located. It may also be necessary to provide more resources for occupational therapy and physiotherapy.

RECOMMENDATIONS FOR FUTURE RESEARCH.

It is suggested that future research into the problem of proximal femoral fractures should concentrate on attempting to evaluate the role of multi-disciplinary assessment at the time of admission to hospital of those elderly people with proximal femoral fractures who are already physically disabled and mentally incompetent. There is a need to evaluate simple care for such patients against the existing predominantly surgical treatment. It may not be possible to conduct a randomised controlled trial of such a policy for the reasons already discussed but it ought to be possible to introduce a change in policy and evaluate the outcome before and after the change. It will, of course, be necessary to ensure that sufficient resources are made available to provide such alternative care away from the acute orthopaedic wards. Such an evaluation should include an assessment of both the costs and the benefits. It is possible that an active decision not to treat some patients surgically might provide more humane care, save money and have no deleterious effect on outcome. Such a policy deserves

evaluation.

IMPLICATIONS FOR THE EVALUATION OF HEALTH CARE.

The findings of the present study have broader implications for the evaluation of health care in general. It is clear that it is considerably more difficult and costly to evaluate health care than it is to evaluate, say, the quality of simple manufactured goods. Because of conceptual complexity and methodological problems it can be difficult to apply the ideology of evaluation in practice. The example of proximal femoral fractures demonstrates this. The formal methodology of evaluation is costly and time consuming and may not be relevant in rapidly changing situations. The implication is that the evaluation of health care needs to be applied selectively and carefully using the full range of techniques available. This should maximise the chances of implementing desired change and closing the loop in the cycle of evaluation. Certain criteria are relevant in deciding priorities for evaluation.

CRITERIA FOR DECIDING PRIORITIES FOR EVALUATION.

It is suggested that where a particular health care activity consumes large amounts of resources then this should be a priority for evaluation. An example might be tonsillectomy which was, at one time, a very frequent procedure and for this reason consumed significant amounts of resources even though the unit costs of treatment were not particularly high. Other activities consume

substantial resources because of high unit costs. For example, it has been estimated that the direct costs of cardiac transplantation in the first year are about $125,000 [173]. Other health care activities may have high intangible costs, either because the treatment itself is unpleasant, or because of unpleasant side effects. Radical mastectomy is an example of unpleasant treatment and chemotherapy for malignant disease is an example of unpleasant side effects. Where the provision of resources for health care is particularly fragmented, there may be a case for evaluation since the costs of care may be much greater than realised. The care of elderly people is funded from a variety of sources and this can make it difficult to estimate the true costs to society of care [174].

Another criterion which can be applied in attempting to decide priorities for evaluation relates to the perceived effectiveness of care. Where there are large variations in the rate of provision of care, either within or between countries, this should suggest that factors other than need are influencing the allocation of resources. These variations may also suggest that there is a lack of agreement about the objectives and effectiveness of such care. The example of treatment for end stage renal disease has already been cited. For some health care activities there may be inadequate evidence of effectiveness. This would be true of new technologies such as extra-corporeal lithotripsy which have yet to be adequately evaluated in practice, or of new drugs such as for the treatment of the acquired immune deficiency syndrome. Other treatments may have been established for many years without convincing evidence of effectiveness. Examples might include radical mastectomy or elective appendicectomy. There may be grounds for questioning the effectiveness of those health care activities where the objectives of care seem uncertain or not agreed. The use of minor tranquillisers and hypnotics might fall into this category.

Where the patients or consumers of health care are not able actively to participate in decisions about treatment because of mental incompetence there may be particularly strong moral reasons for evaluation. Modern policies of caring for mentally ill and mentally handicapped people in the community have developed partly because of a recognition of the dehumanising effect of incarcerating such people in institutions. There is a need to evaluate health care for incompetent or non-autonomous consumers in order to ensure that their rights are not infringed [74].

There are good reasons for allocating priority in evaluative studies to those areas where change is likely to be implemented as a result of evaluation. In the National Health Service evaluation is more likely to result in desired changes being implemented if it concentrates on those areas which are perceived as being relevant to political or management problems. For example, day case surgery has been promoted as a means of reducing long surgical waiting lists which are politically embarassing. Piauchaud and Weddell reported on a randomised controlled trial of injection sclerotherapy versus conventional treatment of varicose veins which showed that at 3 years following surgery the benefits in the two groups were similar although the latter was much more costly [175]. Longer follow-up has suggested that the long term benefits of routine surgery are greater than those of injection sclerotherapy. Nevertheless, the results of this trial were influential in encouraging both surgeons and policy makers to implement more day surgery for other conditions. The relevance of the study to contemporary management and political problems facilitated the implementation of change. It follows that evaluation is most likely to be successful where the managers of the health service are committed to change in a particular activity and, therefore, where they provide the initial impetus for evaluative studies.

Change is also facilitated where clear alternative health care interventions can be identified. These alternatives may be between prevention and cure, between different treatments, between different places of treatment (i.e. home or hospital), or between day case or in-patient treatment. One of the problems with proximal femoral fractures is in identifying viable alternatives to current management. A factor which may militate against using evaluation to implement desired change is rapid change either in a health care problem or in the environment. The epidemic of the acquired immune deficiency syndrome has developed into one of the most important public health problems of the day over a period of about 6 years. However desirable the evaluation of different drug treatments for this condition might be, the public health response to the problem must concentrate on prevention and there is no time for the luxury of formal evaluation of preventive measures.

Finally, one of the most important criteria for deciding priorities for evaluation must be the feasibility of studies. The feasibility will depend upon the ease with which data can be obtained and upon the resources of time, money and manpower available for evaluation. The use of microcomputers to monitor activity in acute orthopaedic units is a recent innovation [176]. Data which are routinely collected perhaps for management purposes are likely to be more easily obtained than data which require an ad hoc study. In the present study an attempt has been made to evaluate trends in the efficiency of health care using routine hospital activity data. Earlam has reported an audit of hospital treatment for oesophageal cancer using North East Thames HAA data which suggested that patients with terminal cancer were being admitted inappropriately to acute hospital beds [177]. The problems with such data are that they may be of variable and unknown accuracy and, with the exception of routine mortality data, they seldom

relate to individual members of defined populations. Another problem is that such data do not provide useful measures of health outcomes in terms of morbidity or health status.

Applying some of these criteria to the problem of proximal femoral fractures it is clear that they consume significant and increasing amounts of scarce health care resources. They are common and the unit costs of treatment can be substantial. The indirect costs to society of caring for patients with proximal femoral fractures are probably high because of the burden on carers once the patient is discharged back to the community. Because of the need for after care in the community, even though these fractures are nearly all treated in hospital, the provision of resources for care is somewhat fragmented between different public and private sectors. The treatment is not pleasant and complications are frequent so that the intangible costs of treatment are high. There are also real grounds for questioning the efficacy of treatment in those elderly people who are already suffering from multiple health problems. Ad hoc studies of the outcome of treatment suggest that the efficiency and quality of care are less than satisfactory and there is insufficient evidence of effectiveness in the literature. In those very elderly people with proximal femoral fractures who are already incapacitated, the objectives of treatment may be uncertain. Many of the patients are not competent mentally and are not autonomous and this would suggest the need for careful evaluation of the quality of care. These fractures certainly are a major management problem in the health service and, as the Duthie report concluded, they are a major factor causing lengthening waiting lists for elective orthopaedic surgery [5]. Even though proximal femoral fractures are consuming increasing amounts of health care resources, they are not a new problem and it is worthwhile investing time and effort in trying to improve the

outcome of health care since the problem is not going to go away in the forseeable future. The real problems with attempting to evaluate health care for this condition have been highlighted in the present study: it is costly and time consuming to evaluate outcome in a way which is sufficiently robust to allow for generalisation and comparison, and it is very difficult to identify alternative strategies for dealing with the problem.

Chapter 7

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS.

1. The findings of a prospective cohort study of 396 proximal femoral fractures in people aged 25 years and over have been presented. In Stockport residents, 325 fractures were ascertained during an 18 month period starting on 1st March, 1984. The estimated annual incidence rates of proximal femoral fractures in Stockport for both sexes combined increased from 96 per 100,000 in people aged 65 to 69 years, to 1,873 per 100,000 in people aged 85 years or over. The increase in annual incidence with age was approximately exponential from the 6th decade of life onwards in both sexes. The age specific rates for females exceeded those for males beyond the age of 60 years. This pattern of variation of incidence with age and sex was similar to that found in other studies.

2. Two hundred and thirty-seven fracture cases occurred in residents of Stockport during the one year period from 1st September, 1984. These patients were included in the main prospective cohort study. The female:male ratio was 5.2 : 1 and the median age at the time of the fracture was 74.5 years for men and 80 years for women. The median age for both sexes combined was 79 years.

3. One hundred and forty-three of the 237 cases (60 per cent) were intra-capsular fractures.

4. Two hundred and fifteen of the 237 cases (91 per cent) were the first proximal femoral fracture experienced by the individual.

5. Most of the injuries associated with proximal femoral fractures (65 per cent) occurred between 7 am and 6 pm and the modal time of injury was 10 am. There was a small secondary peak of fracture occurrence between 9 and 11 pm. Eleven per cent of fractures occurred between midnight and 7 am.

6. Most fractures (94 per cent) followed falls. Twenty-two per cent (51/233) followed falls in a public place and 24 per cent (57/233) followed falls either in hospital or in residential institutions.

7. In 10 patients the date of the fracture was not known either because the patient was confused or because the fracture was spontaneous. Most of the fracture cases (157/227 or 69%) were admitted to hospital on the same day as the fracture. In a few patients the admission to hospital was delayed because of delays in diagnosis.

8. Ninety-six per cent of fracture cases were in retired people, 41 per cent in people who lived alone, 74 per cent in people who had an active medical problem before the fracture and 74 per cent in people who were on regular drug treatment. The median score on a test of mental function at the time of admission to hospital was 25 out of a possible maximum of 35. Eleven per cent (24/227) of fractures were in patients who were unable to answer any of the 35 questions. Fifty-seven per cent of fracture cases were in people who could walk without assistance or walking aids before the fracture and 28 per cent were in people who walked with the aid of 1 stick. Only 37 per

cent of the fracture cases were in people who were fully independent (i.e. they were continent of urine and faeces and were independent in feeding, transferring, toileting, dressing and bathing). Sixty-six per cent of cases were in people who lived in their own private household and 15 per cent in residents of nursing or residential homes. These findings suggest that patients with proximal femoral fractures already have a high prevalence of physical and mental impairments.

9. The 237 patients occupied, within the first 6 months following their fracture, a total of 12,291 hospital bed days. The mean duration of hospital stay was 51.9 days. On average, each patient occupied an acute bed for 31 days, a rehabilitation bed for 15 days and a continuing care bed for 5 days. However, 22 patients (9%) were still in hospital 6 months (182 days) following the proximal femoral fracture and the median duration of total hospital stay was 30 days. The rehabilitation beds at Cherry Tree Hospital were only available to female patients of whom 28 per cent (55/199) were admitted to these beds.

10. Ninety per cent (213/237) of the fracture cases were treated surgically. The choice of treatment was mainly determined by the type of proximal femoral fracture. Garden screws were mainly used for sub-capital fractures with little or no displacement. Hemi-arthroplasty (mainly with a Moore prosthesis) was the favoured treatment for displaced sub-capital fractures at Stockport Infirmary, although total hip replacement with a low friction arthroplasty was the preferred treatment at Wythenshawe hospital. A sliding compression screw plate or dynamic hip screw was the preferred treatment for trochanteric fractures. Of the patients treated surgically 98 per cent (209/213) had a general anaesthetic. The median time interval between admission to hospital and surgical

treatment in those patients treated surgically was between 1 and 2 days.

11. Sixty-three per cent of the 237 fracture cases were complicated by medical problems in hospital. Seventeen (8%) of the 213 patients treated surgically had a further operation on the fracture within 6 months of the first admission to hospital. Another patient had 2 further operations on the fracture in the 6 months following the original admission. Seven of the further operations were total hip replacements.

12. All but 3 of the 237 patients were followed up at 182 days following the fracture. The estimated cumulative probability of survival at 180 days was 0.704 and the 95 per cent confidence limits were 0.646 to 0.762. The commonest causes of death within the first 6 months following the fracture were myocardial infarction, cardiac failure, pulmonary embolism and stroke. Femoral neck fracture, ICD code 820, was mentioned as a cause of death in 33 of 63 cases in which the certified cause of death could be traced.

13. Fifty-two per cent of all 237 fracture cases had returned to their usual place of residence by 6 months following the fracture. In 46 per cent of the 237 cases the patient was either dead at 6 months or had moved to another residence because of increased dependency consequent upon the fracture. Of the 167 survivors, 23 (14%) could no longer live alone following the fracture. In 80 of the 167 survivors (48%) the ability to perform the normal activities of daily living as measured by the dependency score had deteriorated during the 6 month period. In 7 per cent the dependency score had improved. In 108 survivors (65%) the score for walking ability had deteriorated over the 6 months following the fracture. The walking ability improved in only 2 people. For example, 48 people walked

with a frame compared with 19 before the fracture. Only 28 (17%) were able to walk without assistance or walking aids compared with 57% before the fracture. Seventy-six per cent of survivors who could give sensible answers (111/146) reported that their activities were more limited at 6 months following the fracture and 67 per cent reported that their hip was still painful. Many of the survivors had become confined to their living quarters because of the hip fracture and lack of self confidence was a prominent complaint. Thirty-two per cent of the survivors (53/167) who were able to climb a flight of stairs without assistance at the time of the fracture could no longer do so at 6 months following the fracture. Sixteen per cent (26/167) who had been able to rise from a chair without assistance could no longer do so.

14. Several patient characteristics at the time of admission to hospital were significantly associated on univariate analysis with decreased survival during the first 6 months following the fracture. These included: an extra-capsular fracture, a fracture occurring in a retired person, the presence of an active medical problem at the time of the fracture, regular drug treatment at the time of the fracture, a low blood haemoglobin concentration, advanced age, inability to climb stairs before the fracture, a high blood phosphate concentration and a low mental test score. There was significant heterogeneity between groups for certain grouped variables including walking ability before the fracture, the dependency score before the fracture, the fracture mechanism and primary treatment, indicating that the different groups within each of these 4 variables had different survival experiences.

15. These factors were, however, inter-related and it was necessary to consider their joint effects. On multivariate regression analysis, 5 variables had a significant independent association with survival within the first 6 months. These included: a high blood phosphate level, a low mental test score, a fracture which did not follow a fall in a public place, the presence of an active medical problem at the time of the fracture, and advanced age.

16. The regression was used arbitrarily to identify a `poor risk´ group of patients with respect to survival. This group included patients with a blood phosphate level greater than or equal to 0.8 mM/l, whose fracture was not associated with a fall in a public place, who gave a history of an active medical problem at the time of the fracture and who had a mental test score on admission to hospital of less than 16 out of a possible maximum of 35. This group included 38 cases or 13 per cent of the total cases. The model predicted survival for this group of 38 per cent at 179 days following the fracture, compared with a predicted survival of 80 per cent at 178 days following the fracture in the remaining favourable risk group.

17. The association between the independent variables and outcome as measured in terms of walking ability at 6 months following the fracture was also examined using a multiple regression model. Seven variables: sex, whether the patient was a driver before the fracture, whether the patient could climb a flight of stairs unaided before the fracture, walking ability before the fracture, dependency score before the fracture, the interval between admission to hospital and primary treatment, and whether the patient lived in Stockport, had an independent association with the probability of a `successful´ outcome. Using the value P = 0.325 as a criterion for

predicting a successful outcome, 72 per cent of successful outcomes (41/57) were correctly predicted and 85 per cent of unsuccessful outcomes (112/131) were correctly predicted. This was the value that maximised both the `sensitivity´ and `specificity´ of the model.

18. The cumulative proportion of proximal femoral fracture patients aged 65 years and over who were Stockport residents who survived 6 months following the fracture was 67 per cent and this compared with a cumulative survival for the general elderly population in Stockport of 97 per cent at 6 months.

19. The standardised death rates for femoral neck fractures in elderly people in England and Wales have decreased consistently between 1968 and 1983. The hospital fatality ratio for femoral neck fractures in people aged seventy-five years and older has decreased over the same period but there has been no significant reduction in hospital fatality for people aged 65 to 74 years. There has been a significant reduction in mean durations of hospital stay for people aged seventy-five years and older and a highly significant reduction for people aged 65 to 74 years. These data suggest that the efficiency of hospital care for proximal femoral fractures in England and Wales has improved in recent years. There are, however, problems in interpreting these data.

20. Review of the accuracy of routine hospital activity statistics for Stockport showed that 14 per cent of proximal femoral fracture cases were not included in the computer file. There were 23 entries which were incorrectly included as proximal femoral fractures in Stockport residents (7 per cent).

21. Despite the apparent improvement in the efficiency of hospital care for proximal femoral fractures, the prospective cohort study has shown that the efficiency of hospital care for these fractures in Stockport is still less than satisfactory. Approximately 90 per cent of patients had surgical primary treatment and the multivariate analysis did not suggest that treatment had an independent effect on outcome.

22. Because of the increasing proportion of very old people in the population and the strong association between age and the incidence of proximal femoral fractures, these fractures are likely to require increasing resources for health care. There is, therefore, a need to consider strategies for improving health care for this condition.

23. The prospects for preventing significant numbers of proximal femoral fractures are not good. There is, therefore, a need to improve the cost-effectiveness of treatment.

24. It is suggested that none of the randomised, controlled trials of different treatments for proximal femoral fracture have identified feasible ways of improving overall cost-effectiveness of treatment. There is insufficient evidence that surgical treatment for those elderly people who are already incapacitated mentally and physically at the time of fracture is effective.

25. Previous recommendations that there should be multi-disciplinary assessment and care for such patients with proximal femoral fractures are supported as is the need for operative fixation and early mobilisation in those elderly people who are reasonably independent and mentally competent at the time of

fracture.

26. It is unlikely that reliable clinical decision rules will become available in the near future to assist orthopaedic surgeons in deciding the treatment for patients with proximal femoral fractures. It is recommended that orthopaedic surgeons should decide not to treat surgically those elderly people who are already mentally incompetent and physically incapacitated at the time of the fracture. It is possible that for these patients simple care including analgesia, traction and good nursing care would be equally effective, more humane and less costly than primary surgical treatment. There is a need to evaluate such a policy. In order for such a policy to be effective, it is necessary that there should be sufficient geriatricians to assess such elderly people at the time of admission to hospital and there should be sufficient resources for such alternative care.

27. Strategic plans in Stockport should include the transfer of the emergency orthopaedic beds to the district general hospital so that both acute geriatric and acute orthopaedic care are provided on the same hospital site.

28. The findings of the present study have implications for the evaluation of health care in general. The example of proximal femoral fractures is particularly relevant to two broader debates within health care evaluation: technology assessment/surgical audit, and the health care of elderly people.

29. The ideology of evaluation emphasises that decisions about the allocation of scarce health care resources should be as rational as possible. The evaluation of health care should include both an assessment of the efficiency of care and an assessment of quality.

Implicit in the ideology of evaluation is the idea that as a result of evaluation, desired change will be implemented. However, there are real problems in applying the ideology of evaluation in the rapidly changing real world.

30. There is a range of different techniques for evaluating health care and these vary in the cogency of the evidence that they provide. Some of these techniques can be costly in terms of money and skilled manpower and can take time. There may sometimes be a need to make decisions about the allocation of scarce resources with incomplete information. The different techniques for evaluating health care must be applied selectively and intelligently with due regard to the likelihood of implementing desired change and thereby closing the loop in the cycle of evaluation.

31. There is a need to agree priorities for evaluation in health care. Certain criteria are relevant in agreeing such priorities: these relate to the amount of resources consumed, the perceived effectiveness of the health care activity, moral considerations, the likelihood of implementing change and feasibility.

32. Applying these criteria, proximal femoral fractures would appear to deserve priority for evaluation. However, it is both costly and time consuming to obtain relevant information and there are real problems in defining alternative approaches to this difficult health care problem.

APPENDIX.

PROXIMAL FEMORAL FRACTURES IN STOCKPORT - DATA COLLECTION PROFORMA.

IDENTIFICATION SHEET.

SURVEY NUMBER	:	__ __ __
SURNAME	:	
FORENAMES	:	
SEX	: MALE 1 FEMALE 2	__
ADDRESS	:	
	.....	
	TEL:	
HOSPITAL NUMBER	:	
DATE OF ADMISSION	:	__ __ __ __ __ __
NAME OF RELATIVE	:	
	TEL:	
GENERAL PRACTITIONER	:	
	TEL:	

TYPE OF FRACTURE	:	R	L	
	STAGE I	1	2	
	STAGE II	3	4	
	STAGE III	5	6	
	STAGE IV	7	8	
	TROCH.	9	10	
	CERVICAL	11	12	
	NOT KNOWN	99		__ __
X-RAY REPORT	:			
	.....			
DATE OF BIRTH	:			__ __ __ __ __ __
DATE OF FRACTURE	:			__ __ __ __ __ __
DATE OF ADMISSION	:			__ __ __ __ __ __
INTERVAL BETWEEN FRACTURE AND ADMISSION TO HOSPITAL	: .....(DAYS)			__ __ __
AGE AT FRACTURE	: .....(YEARS)			__ __ __
TIME OF FRACTURE	: .....(24 HR CLOCK)			__ __ __ __
LIVING ALONE BEFORE FRACTURE	: YES	1		
	NO	0		
	NK	9		__
RETIRED AT TIME OF FRACTURE	: YES	1		
	NO	0		
	NK	9		__
CAR DRIVER BEFORE FRACTURE	: YES	1		
	NO	0		
	NK	9		__
HOME HELP BEFORE FRACTURE	: YES	1		
	NO	0		
	NK	9		__
DISTRICT NURSE BEFORE FRACTURE	: YES	1		
	NO	0		
	NK	9		__
PREVIOUS FRACTURE	: YES	1		
	NO	0		
	NK	9		__

MOBILITY IN MONTH BEFORE FRACTURE.

CLIMB A FLIGHT OF STAIRS? : YES 1
NO 0
NK 9 ___

GET OUT OF CHAIR? : YES 1
NO 0
NK 9 ___

WALKING : UNAIDED 1
1 STICK 2
2 STICKS 3
FRAME 4
1 PERSON 5
2 PEOPLE 6
CHAIRBOUND 7
BEDBOUND 8
NOT KNOWN 9 ___

RESIDENCE BEFORE FRACTURE : OWN HOME 1
WITH RELATIVES 2
REST/NURSING HOME 3
HOSPITAL BED 4
OTHER 5
NOT KNOWN 9 ___

IF OTHER, SPECIFY : .....

MEDICAL PROBLEM : YES 1
NO 0
NK 9 ___

IF YES, SPECIFY : .....

DRUG TREATMENT : YES 1
NO 0
NK 9 ___

IF YES, SPECIFY : .....
.....

DEPENDENCY SCORE BEFORE FRACTURE

INDEPENDENT IN FEEDING, TRANSFERRING, TOILETING, DRESSING, BATHING AND CONTINENT OF URINE AND FAECES	1	
INDEPENDENT IN ALL BUT ONE OF THESE	2	
INDEPENDENT IN ALL BUT BATHING AND ONE OTHER	3	
INDEPENDENT IN ALL BUT BATHING, DRESSING AND ONE OTHER	4	
INDEPENDENT IN ALL BUT BATHING, DRESSING, TOILETING AND ONE OTHER FUNCTION	5	
INDEPENDENT IN ALL BUT BATHING, DRESSING, TOILETING TRANSFERRING AND ONE OTHER FUNCTION	6	
DEPENDENT IN ALL SIX FUNCTIONS	7	
NOT KNOWN	9	__

BLOOD BIOCHEMISTRY ON ADMISSION

HAEMOGLOBIN	:	__ __ . __
CALCIUM	:	__ . __ __
PHOSPHATE	:	__ . __ __
ALKALINE PHOSPHATASE	:	__ __ __ __
ALBUMIN	:	__ __
CORRECTED CALCIUM	:	__ . __ __

MECHANISM OF THE FRACTURE

SPONTANEOUS, PATHOLOGY	:	1
SPONTANEOUS, NO PATHOLOGY	:	2
FALL - PRIVATE HOME/GARDEN	:	3
FALL - PUBLIC PLACE	:	4
FALL - RESIDENTIAL INSTITUTION	:	5
ROAD TRAFFIC ACCIDENT	:	6
OTHER	:	7
NOT KNOWN	:	9

IF OTHER, SPECIFY: .....

DETAILS OF INJURY: .....

MENTAL TEST SCORE ON ADMISSION

NAME	:	1
AGE	:	1
TIME(HOUR)	:	1
TIME OF DAY	:	1
DAY OF WEEK	:	1
DATE	:	1
MONTH	:	1
SEASON	:	1
YEAR	:	1
PLACE - NAME	:	1
STREET	:	1
TOWN	:	1
TYPE OF PLACE	:	1
DATE OF BIRTH	:	1
PLACE OF BIRTH	:	1
SCHOOL ATTENDED	:	1
OCCUPATION	:	1
NAME OF SIBS/WIFE	:	1
NAME OF ANY TOWN WHERE PATIENT HAD WORKED	:	1
NAME OF EMPLOYERS	:	1
DATE OF WORLD WAR I*	:	1
DATE OF WORLD WAR II*	:	1
MONARCH	:	1
PRIME MINISTER	:	1

NAME AND ADDRESS RECALL (5 MINUTES)
MR JOHN BROWN
42 WEST ST
GATESHEAD : 5

MONTHS OF YEAR BACKWARDS	:	2
COUNTING 1 TO 20	:	2
COUNTING 20 TO 1	:	2

* 1/2 FOR APPROXIMATION WITHIN 3 YEARS.

MAXIMUM POSSIBLE SCORE = 35.

TOTAL SCORE : __ __

STOCKPORT RESIDENT : YES 1
NO 0
NK 9 __

PRIMARY TREATMENT IN STOCKPORT: YES 1
NO 0
NK 9 __

PRIMARY TREATMENT

NONSURGICAL	:	1
GARDEN SCREWS	:	2
MULTIPLE PINS	:	3
BLADE PLATE	:	4
DYNAMIC HIP SCREW	:	5
THOMPSON HEMIARTHROPLASTY	:	6
MOORE HEMIARTHROPLASTY	:	7
DOUBLE INTERFACE HEMIARTHROPLASTY	:	8
TOTAL HIP REPLACEMENT	:	9
CONDYLOCEPHALIC NAILING	:	10
OTHER	:	11
NOT KNOWN	:	99

IF OTHER, SPECIFY: .....

DATE OF FIRST OPERATION : __ __ __ __ __ __

INTERVAL BETWEEN ADMISSION AND FIRST OPERATION (DAYS) : __ __ __

DETAILS OF FURTHER SURGICAL TREATMENT WITHIN 6 MONTHS: .....

.....

MEDICAL COMPLICATIONS : YES 1
NO 0
NK 9 __

IF YES, SPECIFY: .....

.....

DATE OF DISCHARGE : __ __ __ __ __ __

INTERVAL BETWEEN ADMISSION AND DISCHARGE (DAYS) : __ __ __

DATE OF DEATH WITHIN 6 MONTHS : __ __ __ __ __ __

INTERVAL BETWEEN FRACTURE AND DEATH (DAYS) : __ __ __

FOLLOW-UP AT 6 MONTHS FOLLOWING FRACTURE

RESIDENCE	: AS BEFORE	1	
	NHS HOSPITAL	2	
	NURSING/REST HOME	3	
	WITH RELATIVES	4	
	OWN HOME	5	
	OTHER	6	
	NOT KNOWN	9	___
LIVING ALONE	: YES	1	
	NO	0	
	NK	9	___
CLIMB STAIRS	: YES	1	
	NO	0	
	NK	9	___
GET OUT OF CHAIR	: YES	1	
	NO	0	
	NK	9	___
WALKING SCORE (CODE AS BEFORE):			___
HOME HELP	: YES	1	
	NO	0	
	NK	9	___
DISTRICT NURSE	: YES	1	
	NO	0	
	NK	9	___
CAR DRIVER	: YES	1	
	NO	0	
	NK	9	___
DEPENDENCY SCORE (CODE AS BEFORE)			___

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